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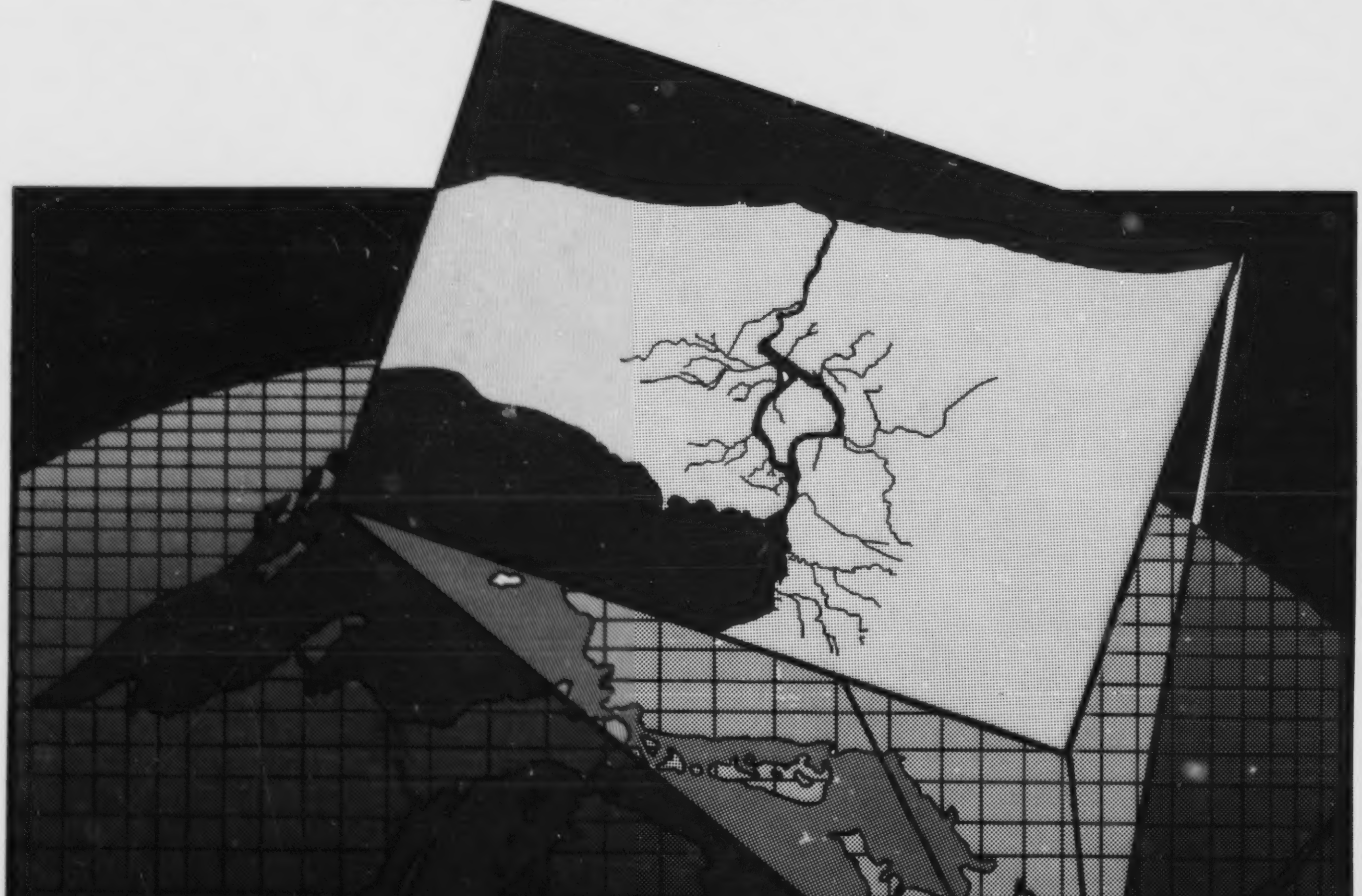

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16. ABSTRACT

American and Canadian monitoring of the quality of the Niagara River has indicated a need to assess contamination entering the river through the groundwater system. The contamination probably emanates from point and nonpoint sources in the adjacent area, along the U.S. side of the Niagara River from Lake Erie to Lewiston, approximately 20 miles downstream, which contains a high density of chemical manufacturing facilities and waste-disposal sites.

164 of the 215 hazardous waste disposal sites in Erie and Niagara Counties, New York are within 3 miles of the Niagara River. In 1982, the USGS, in co-operation with the USEPA and the NYDEC made a preliminary hydrogeologic and chemical evaluation of 138 of these 164 toxic waste disposal sites. The purpose of the investigation was to identify sites that are possible sources of contamination to the ground-water system. The study entailed a general literature review, site reconnaisance and sampling, and a regional drilling and sampling program to obtain background hydrogeologic data for reference.

61 of the 138 studies sites were designated as having a major potential for contaminant migration.

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By

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Todd S. Miller and Philip B. Duran

Prepared by the U.S. Geological Survey

in cooperation with the

New York State Department of Environmental Conservation

for the

U.S. ENVIRONMENTAL PROTECTION AGENCY

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FOREWORD

The Great Lakes National Program Office (GLNPO) of the United States Environmental Protection Agency was established in Region V, Chicago, to focus attention on the significant and complex natural resource represented by the Great Lakes.

GLNPO implements a multi-media environmental management program drawing on a wide range of expertise represented by universities, private firms, State, Federal, and Canadian governmental agencies, and the International Joint Commision. The goal of the GLNPO program is to develop programs, practices and technology necessary for a better understanding of the Great Lakes system. GLNPO also coordinates U.S. actions in fulfillment of the Agreement between Canada and the United States of America on Great Lakes Water Quality of 1978.

This cooperative study was supported by GLNPO, USEPA Region II, New York State Department of Environmental Conservation, and United States Geological Survey funds to define more clearly the interactions between groundwater and surface water in the Niagara River area.

CONTENTS

Page

List of sites studied xxiii
Abstract 1
Introduction 1
  Purpose and scope 3
  Acknowledgments 3
Methods of investigation 4
  Individual site studies 4
    Assignment of site numbers 4
    Literature review 5
    Drilling and coring 5
    Substrate and water sampling 5
    Electromagnetic-conductivity survey 9
    Study of dredge-spoil-containment sites 9
  Regional hydrologic investigation 9
    Hydrogeology, stratigraphy, and water quality 9
    Monitoring wells 12
    Bedrock drilling 13
  Quality assurance for chemical data 13
    Practices 13
    Results 17
Evaluation of contaminant migration 30
  Qualitative assessment 30
  Quantitative assessment 30
    General considerations 30
    Method of computation 32
Regional hydrologic evaluation 34
  Buffalo area 35
    Geology 35
    Aquifer lithology and water-bearing characteristics 39
    Ground-water quality 40
  Tonawanda area 42
    Geology 42
    Aquifer lithology and water-bearing characteristics 44
    Ground-water quality 45
  Niagara Falls area 49
    Geology 49
    Aquifer lithology and water-bearing characteristics 52
    Ground-water quality 56
Results of hydrologic and chemical evaluation 71
Guidelines for future studies 75
  Site studies 75
  Modeling of regional ground-water flow 77
Summary 78
Sources of data 80
Appendices 85
  A. Buffalo area site descriptions 91
  B. Tonawanda area site descriptions 175
  C. Niagara Falls area site descriptions 289

PLATES

(in pocket)

1. Location of sites in Buffalo area.
2. Location of sites in Tonawanda area.
3. Location of sites in Niagara Falls area.

ILLUSTRATIONS

Page

Figure 1. Map showing location of study area in Erie and Niagara Counties........ 2

2. Horizontal and vertical ground-water gradients in a generalized hydrologic section........ 33

3-4. Maps of Buffalo area showing:

3. Bedrock geology of the Buffalo area........ 36

4. Surficial geology of the Buffalo area........ 37

5. Map showing surficial geology of Tonawanda area, N.Y........ 43

6. General geologic column of the Niagara Falls area........ 50

7-8. Maps showing:

7. Surficial geology of the Niagara Falls area........ 51

8. Potentiometric surface of the upper water-bearing zones of the Lockport Dolomite and location of bedrock wells in the Niagara Falls area........ 53

Buffalo Area (Appendix A)

Figure A-1. Location of sampling holes and electromagnetic survey lines at Anaconda Company, site 113, Buffalo........ 94

A-2. Results of electromagnetic conductivity survey at Anaconda Company, site 113, Buffalo........ 96

A-3 - A-4. Maps showing:

A-3. Location of monitoring wells at Bethlehem Steel, site 118, Lackawanna........ 98

A-4. Water-table altitude and location of sampling holes at Buffalo Color Corporation, sites 120-122, Buffalo..... 103

ILLUSTRATIONS (continued)

Page

Figures A-4 - A-12. Maps showing:

A-5. Location of sampling holes at Hanna Furnace Corporation, site 135, Buffalo...................... 106

A-6. Location of sampling holes at McNaughton-Brooks, Inc., site 138, Buffalo..................... 108

A-7. Location of sampling holes at Houdaille Industries--Manzel Division, site 140, Buffalo...... 112

A-8. Location of sampling holes at Mobil Oil Corporation, site 141, Buffalo...................... 115

A-9. Location of sampling holes at Otis Elevator, site 144, Buffalo.................................. 118

A-10. Location of sampling holes at Ramco Steel, site 147, Buffalo... 121

A-11. Potentiometric surface and location of sampling holes at Republic Steel, site 148, Buffalo, August 1979 and February 1982...................... 125

A-12. Location of sampling holes at Alltift Landfill, site 162, Buffalo.................................. 126

A-13. Generalized geologic column of formations underlying the Alltift Landfill, site 162, Buffalo.................... 127

A-14 - A-19. Maps showing:

A-14. Location of sampling holes at Empire Waste, site 173, Buffalo.................................. 133

A-15. Location of sampling holes at Lehigh Valley Railroad, site 190, Buffalo............................. 135

A-16. Location of sampling holes at Niagara Frontier Port Authority, site 196, Buffalo.................. 141

A-17. Location of sampling holes at Procknal and Katra, site 200, Blasdell................................ 142

A-18. Location of sampling holes on Squaw Island, site 203, Buffalo... 145

A-19. Location of sampling holes and electromagnetic-conductivity survey lines at Donner Hanna Coke, site 217, Buffalo................................. 152

ILLUSTRATIONS (continued)

Page

Figure A-20. Results of electromagnetic-conductivity survey at Donner Hanna Coke, site 217, Buffalo 152

A-21 - A-25. Maps showing:

A-21. Location of sampling holes at West Seneca Transfer Station, site 220, West Seneca 157

A-22. Location of monitoring wells at Times Beach disposal site, site 241, along Lake Erie, Buffalo.... 158

A-23. Location of sampling holes at Allied Chemical, Hurwitz-Ranne Hopkins Street, site 249, Buffalo...... 163

A-24. Location of monitoring wells at Small Boat Harbor Containment Site, site 253, along Lake Erie, Buffalo 168

A-25. Location of monitoring wells at Buffalo Harbor Containment Site, site 254, along Lake Erie, Lackawanna 171

Tonawanda Area (Appendix B)

Figure B-1. Location of sampling holes and monitoring well at Buffalo Pumps Division, site 6, North Tonawanda 177

B-2. Map showing location of monitoring wells at Occidental Chemical-Durez Division, sites 24 through 37, North Tonawanda 178

B-3. General geologic column of formations underlying Occidental Chemical-Durez Division, sites 24 through 37, North Tonawanda 179

B-4 - B-7. Maps showing:

B-4. Location of monitoring wells and surface-water samples at National Grinding Wheel, site 50, North Tonawanda.. 183

B-5. Direction of ground-water flow at National Grinding Wheel, site 50, North Tonawanda 185

B-6. Locations of sampling holes and monitoring wells at Frontier Chemical Company, site 67, Pendleton...... 188

B-7. Location of monitoring wells at Gratwick-Riverside Park, site 68, North Tonawanda 193

ILLUSTRATIONS (continued)

Page

Figures B-8 - B-9. Maps showing:

B-8. Location of sampling holes and monitoring wells at Holiday Park, site 72, North Tonawanda............. 194

B-9. Location of monitoring wells and electromagnetic-conductivity survey lines at Nash Road, site 93, Wheatfield.. 200

B-10. Diagram showing effect of buried pipe on electromagnetic-conductivity reading.. 201

B-11. Graphs showing results of electromagnetic-conductivity survey at Nash Road, site 93, Wheatfield, lines 1 through 8. 202

B-12 - B-21. Maps showing:

B-12. Location of sampling holes at R. P. Adams Company, site 103, Tonawanda.................................. 208

B-13. Location of sampling holes at Allied Chemical, Tonawanda, site 105, Tonawanda....................... 211

B-14. Location of sampling holes at Allied Chemical, Tonawanda, site 106, Tonawanda....................... 213

B-15. Location of sampling holes and surface sample at Tonawanda Coke, sites 108, 109, and 110, Tonawanda... 215

B-16. Location of sampling holes at Aluminum Match Plate Corporation, site 111, Tonawanda............... 225

B-17. Location of sampling holes at Columbus McKinnon Corporation, site 123, Tonawanda..................... 228

B-18. Location of sampling holes and electromagnetic-conductivity survey lines at Dunlop Tire and Rubber Company, sites 125, 126, and 127, Tonawanda... 231

B-19. Graphs showing results of electromagnetic-conductivity survey at Dunlop Tire and Rubber Company, sites 125, 126, and 127, Tonawanda, lines 1 through 5.................................... 233

B-20. Location of monitoring wells at Dupont Company, site 128, Tonawanda.................................. 236

B-21. Location of sampling holes at FMC Corporation, site 131, Tonawanda.................................. 240

ILLUSTRATIONS (continued)

Page

Figures B-22 - B-25. Maps showing:

B-22. Location of sampling holes at INS Equipment Corporation, site 136, Tonawanda.................... 244

B-23. Location of sampling holes at Pennwatt-Lucidol Division, site 137, Tonawanda....................... 248

B-24. Location of sampling holes at Shanco Plastics and Chemicals, sites 150 and 151, Tonawanda............ 252

B-25. Location of sampling holes, monitoring wells, and electromagnetic conductivity survey lines at Spaulding Fibre Company, sites 153 through 155b, Tonawanda.. 254

B-26. Graph showing results of electromagnetic-conductivity survey at Spaulding Fibre, sites 154 and 155, Tonawanda.... 257

B-27 - B-28. Maps showing:

B-27. Location of sampling holes at J. H. Williams Company, site 160, Tonawanda....................... 260

B-28. Locations of sampling holes, surface sample, and electromagnetic-conductivity survey lines at Huntley Power Station, site 182, Tonawanda.......... 265

B-29. Graph showing results of electromagnetic-conductivity survey at Huntley Power Station, site 182, Tonawanda, lines 1 through 10.. 266

B-30. General geologic column of formations underlying Seaway Industrial Park Landfill, site 201, Tonawanda............. 276

B-31 - B-32. Maps showing:

B-31. Location of sampling holes at William Strassman Property, site 204, Tonawanda...................... 279

B-32. Location of monitoring wells, sampling holes, surface samples, and electromagnetic-conductivity survey lines at City of Tonawanda Landfill, site 207, Tonawanda.................................... 280

B-33. Graph showing results of electromagnetic-conductivity survey at City of Tonawanda Landfill, site 207, Tonawanda, lines 1 and 2................................. 283

ILLUSTRATIONS (continued)

Page

Figures B-34 - B-35. Maps showing:

B-34. Location of monitoring wells at Botanical Gardens, site 243, North Tonawanda 285

B-35. Location of monitoring wells at Creekside Golf Course, site 252, Amherst 287

Niagara Falls Area (Appendix C)

Figure C-1 - C-7. Maps showing:

C-1. Location of sampling holes at Airco Speer Carbon Graphite, site 2, Niagara Falls 291

C-2. Location of sampling holes at Basic Carbon Company, site 4, Niagara Falls 293

C-3. Location of monitoring wells at Bell Aerospace Textron, site 5, Wheatfield 295

C-4. Geologic cross section of formations underlying Carborundum-Abrasive Division, site 9, Wheatfield... 298

C-5. Potentiometric surface at the overburden-bedrock interface and location of monitoring wells at Carborundum-Abrasive Division, site 9, Wheatfield... 299

C-6. Location of sampling holes at Chisholm Ryder, site 11, Niagara Falls 301

C-7. General geologic cross section of formations underlying Dupont, Necco Park, site 14, Niagara Falls 304

C-8. Maps showing water table altitude and potentiometric-surface altitude at Dupont, Necco Part, site 14, Niagara Falls, March 1981 305

C-9. Graph showing results of electromagnetic-conductivity survey for Dupont, Necco Park, site 14, Niagara Falls..... 307

C-10 - C-11. Maps showing:

C-10. Location of sampling holes at Frontier Bronze Company, site 21, Niagara Falls 309

C-11. Location of sampling holes at Great Lakes Carbon Company, site 22, Niagara Falls 311

ILLUSTRATIONS (continued)

Page

Figures C-12 - C-24. Maps showing:

C-12. Location of monitoring wells screened in unconsolidated deposits and in bedrock at Occidental Chemical, love Canal, site 38, Niagara Falls.. 315

C-13. Water levels in unconsolidated deposits and in bedrock at Occidental Chemical, Love Canal, site 38, Niagara Falls.................................. 316

C-14. Location of monitoring wells, Occidental Chemical--Hyde Park Landfill, site 39, Niagara Falls......... 320

C-15. Altitude of top of the Lockport Dolomite, Occidental Chemical--Hyde Park Landfill, site 39, Niagara Falls.. 321

C-16. Water levels in upper part of Lockport Dolomite, Occidental Chemical--Hyde Park Landfill, site 39, Niagara Falls.. 322

C-17. Altitude of top of the clay/till unit, Occidental Chemical--Buffalo Avenue, S-area, site 41a, Niagara Falls, N.Y.. 326

C-18. Thickness of clay/till unit, Occidental Chemical--Buffalo Avenue, S-area, site 41a, Niagara Falls.... 327

C-19. Bedrock-surface altitude, Occidental Chemical--Buffalo Avenue, S-area, site 41a, Niagara Falls.... 328

C-20. Water levels of February 1980 in the S-area, Occidental Chemical--Buffalo Avenue, site 41a, Niagara Falls.. 329

C-21. Potentiometric surface of bedrock aquifer, April 1979, Occidental Chemical--Buffalo Avenue, S-area, site 41a, Niagara Falls............................ 330

C-22. Water-table altitudes in overburden aquifer, June 1979, Occidental Chemical--Buffalo Avenue Plant, sites 41b through 49, Niagara Falls......... 334

C-23. Water-table altitudes in overburden aquifer, September 1979, Occidental Chemical--Buffalo Avenue Plant, Sites 41b through 49, Niagara Falls......... 335

C-24. Potentiometric surface of bedrock aquifer, June 1979, Occidental--Buffalo Avenue Plant, sites 41b through 49, Niagara Falls................ 336

ILLUSTRATIONS (continued)

Page

Figure C-25. Map showing location of monitoring wells at TAM Ceramics, site 51, Niagara Falls.................................... 338

C-26. Generalized geologic column of formations underlying Olin 102nd Street Landfill, site 56, Niagara Falls........ 340

C-27 - C-29. Maps showing:

C-27. Profile of ground-water flow patterns and contamination plume, Olin 102nd Street Landfill, site 56, Niagara Falls............................ 340

C-28. Water-table altitude at Olin 102nd Street, site 56, Niagara Falls, January 15, 1979........... 341

C-29. Location of electromagnetic-conductivity survey lines at Olin Industrial Welding Corporation, site 57, Niagara Falls............................ 342

C-30. Graphs showing results of electromagnetic-conductivity survey at Olin Industrial Welding Corportion, site 57, Niagara Falls, lines 1 through 8.......................... 343

C-31 - C-32. Maps showing:

C-31. Location of monitoring wells at Olin Buffalo Avenue, sites 58, 59, and 248, Niagara Falls....... 346

C-32. Location of sampling holes and electromagnetic-conductivity survey lines at Stauffer Chemical--Art Park Site, site 63, Lewiston.................. 352

C-33. Graph showing results of electromagnetic-conductivity survey at Stauffer Chemical--Art Park Site, site 63, Lewiston... 353

Figures C-34 - C-36. Maps showing:

C-34. Location of monitoring wells at Reichhold-Varcum Chemical Division, site 66, Niagara Falls.. 356

C-35. Location of sampling holes at Lynch Park, site 76, Wheatfield.............................. 359

C-36. Altitudes of bedrock and ground-water in aquifer and confining unit at Cecos and Niagara Cycling (NEWCO), sites 78a and 78b, Niagara Falls......... 363

ILLUSTRATIONS (continued)

Page

Figures C-49 - C-52. Maps showing:

C-49. Location of sampling holes at Witmer Road, site 90, Niagara Falls.. 397

C-50. Location of sampling holes at Niagara Frontier Transportation Authority, site 92, Wheatfield...... 400

C-51. Location of monitoring wells at Niagara River--Belden site, site 94, Wheatfield................... 402

C-52. Location of surface-water samples and electromagnetic-conductivity survey at Old Creek Bed (Dibacco no. 1), site 95, Niagara................. 404

C-53. Graphs showing results of electromagnetic-conductivity survey at Old Creek Bed (Dibacco no. 1), site 95, Niagara, lines 1, 2, and 3.............................. 406

C-54 - C-59. Maps showing:

C-54. Location of sampling holes at Silbergeld Junk Yard, site 100, Niagara Falls..................... 409

C-55. Location of sampling holes at Rodeway Inn, site 237, Niagara Falls........................... 410

C-56. Location of sampling holes at St. Mary's School, site 238, Niagara Falls........................... 412

C-57. Location of monitoring wells and sampling holes at 97th St. Methodist Church, site 245, Niagara Falls. 416

C-58. Location of monitoring wells at Solvent Chemical, site 251, Niagara Falls........................... 419

C-59. Location of sampling holes and electromagnetic-conductivity survey at Stauffer Chemical Plant, PASNY, site 255, Lewiston......................... 423

C-60. Graphs showing results of electromagnetic-conductivity survey at Stauffer Chemical Plant, PASNY, site 255, Lewiston, lines 1 through 3............................ 425

TABLES

Page

Table 1.--Substrate and water-sample data, 1982-83...................... 6

2.--U.S. Environmental Protection Agency list of recommended priority pollutants....................................... 10

3.--Detection limits and estimated accuracy and precision for water and substrate samples from Niagara River waste-disposal sites, 1982.. 14

4.--Sampling and analysis procedures for experimental constituents 15

5.--Organic compounds identified as a naturally occurring, possibly naturally occurring, or possible artifact compounds in ground water, surface water, and substrates, 1982.......... 18

6.--Contamination of quality-assurance water blanks, 1982......... 20

7.--Surrogate recoveries from water blanks........................ 22

8.--Quality-assurance results for waste-disposal sites............ 23

9.--Surrogate recoveries for ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983.. 28

10.--Surrogate recoveries for ground-water samples from wells in the unconsolidated deposits along the Niagara River, Robert Moses Parkway, N.Y., January 1983...................... 29

11.--Surrogate recoveries for ground-water samples from wells used to characterize area water quality; Buffalo, Tonawanda, and Niagara Falls, N.Y., November 1982............. 29

12.--Sites designated as having a major potential for contaminant migration to ground water....................... 31

13.--Heavy-metal concentrations in samples from undisturbed soils in Buffalo, N.Y., june 1, 1983......................... 40

14.--Analyses of a ground-water sample from well SA-9 in the unconsolidated deposits along Seneca Street, West Seneca, N.Y., November 13, 1982............................. 41

15.--Heavy metal concentrations in substrate samples from undisturbed soils in Tonawanda, N.Y., May 31, 1983 and June 1, 1983.. 45

16.--Analyses of ground-water samples from wells in the unconsolidated deposits along the Niagara River, Tonawanda, N.Y., November 13, 1982....................................... 46

TABLES (continued)

Page

Table 17.--Analyses of ground-water samples from wells in unconsolidated deposits along the Niagara River, Niagara Falls, N.Y., November 10, 1983 58

18.--Analyses of ground-water samples from unconsolidated deposits along the Niagara River-Robert Moses Parkway, Niagara Falls, N.Y., January 13, 1983 61

19.--Analyses of ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983 64

20.--Heavy metal concentration in samples obtained from undisturbed soils in Niagara Falls, N.Y., May 31, 1983 and June 1, 1983 70

21.--Potential for contaminant migration from sites studied 71

22.--Sites that have a major potential for contaminant migration 74

23.--Sampling summary 79

Buffalo Area (Appendix A)

Table A-1. Analyses of ground-water samples from Allied Chemical, site 107, Buffalo, N.Y., July 19, 1982 92

A-2. Analyses of substrate samples from Anaconda Company, site 113, Buffalo, N.Y. 95

A-3. Water-level measurements in monitoring wells at Bethlehem Steel, site 118, Lackawanna, N.Y., July through December 1980 99

A-4. Pumping-test analyses of selected wells at Bethlehem Steel, site 118, in Lackawanna, N.Y. 99

A-5. Analyses of ground-water samples from the Bethlehem Steel, site 118, Lackawanna, N.Y., July through December 1980 100

A-6. Analyses of substrate samples from Hanna Furnace, site 135, Buffalo, N.Y., August 2, 1982 106

A-7. Analyses of substrate samples from McNaughton Brooks, site 138, Buffalo, N.Y. 109

A-8. Analyses of substrate samples from Houdaille Industries, site 140, Buffalo, N.Y. 113

TABLES (continued)

Page

Table A-9. Analyses of substrate samples from Mobil Oil, site 141, Buffalo, N.Y. 116

A-10. Analyses of soil samples from Pratt and Letchworth, site 146, Buffalo, N.Y., 1982 119

A-11. Analyses of substrate and surface-water samples from Ramco Steel, site 147, Buffalo, N.Y., July 22, 1982 121

A-12. Water levels in five deep monitoring wells on Republic Steel, site 148, Buffalo, N.Y. 122

A-13. Analyses of ground-water and surface-water samples from Republic Steel, site 148, Buffalo, N.Y., July 22-23, 1982 123

A-14. Analyses of ground-water samples from wells screened above glaciolacustrine clay at Alltift landfill, site 162, Buffalo, N.Y., July 1978 129

A-15. Analyses of ground-water samples from four wells screened below glaciolacustrine clay at Alltift Landfill, site 162, Buffalo, N.Y., May 1982 131

A-16. Analyses of substrate samples from Empire Waste, site 173, Buffalo, N.Y., July 30, 1982 133

A-17. Analyses of substrate samples from Lehigh Valley Railroad, site 190, Buffalo, N.Y., July-August 1982 138

A-18. Analyses of substrate samples from Niagara Frontier Port Authority, site 196, Buffalo, N.Y., August 5, 1982 141

A-19. Analyses of surface-water and substrate samples from Procknal and Katra, site 200, Blasdell, N.Y., April 27, 1982 143

A-20. Analyses of substrate samples from Squaw Island, site 203, Buffalo, N.Y. 147

A-21. Analyses of substrate samples from Donner Hanna Coke, site 217, Buffalo, N.Y. 153

A-22. Analyses of substrate samples from West Seneca Transfer Station, Buffalo, N.Y., August 26, 1982 156

A-23. Range and mean concentration of selected metals in 16 sediment samples from Times Beach containment site, site 241, Buffalo, N.Y. 159

A-24. Analyses of 16 sediment samples from Times Beach containment site, site 241, Buffalo, N.Y. 160

TABLES (continued)

Page

Table A-25. Analyses of water samples from Times Beach Containment Site, site 241, Buffalo, N.Y., January 11, 1983.................. 161

A-26. Analyses of substrate samples from Allied Chemical (Hurwitz-Ranne), site 249, Hopkins Street, Buffalo, N.Y.............. 165

A-27. Analyses of water samples from Small Boat Harbor Containment Site, site 253, Buffalo, N.Y., January 11, 1983............. 169

A-28.- Analyses of water samples from the Buffalo Harbor Containment Site, site 254, Lackawanna, N.Y., January 10, 1983........... 172

Tonawanda Area

B-1. Analyses of ground-water and sediment samples from Buffalo Pumps Division, site 6, North Tonawanda, N.Y., June 21, 1982 177

B-2. Water-table altitudes in wells at Occidental Chemical-Durez, sites 24-37, North Tonawanda, N.Y., 1980.................... 180

B-3. Analyses of samples from monitoring wells at Occidental Chemical-Durez, sites 24-37, North Tonawanda, N.Y........... 181

B-4. Analyses of surface-water samples from National Grinding Wheel, site 50, North Tonawanda, N.Y., April 6, 1979........ 185

B-5. Analyses of water samples from National Grinding Wheel, site 50, North Tonawanda, N.Y............................... 186

B-6. Analyses of ground-water, surface-water, and substrate samples from Frontier Chemical, site 67, Pendelton, N.Y..... 189

B-7. Analyses of ground-water samples from Gratwick Riverside Park, site 68, North Tonawanda, N.Y., July 28, 1982......... 191

B-8. Analyses of ground-water, surface-water and sediment samples from Holiday Park, site 72, North Tonawanda, N.Y., June 19, 1982 to July 9, 1982..................................... 196

B-9. Analyses of ground-water and substrate samples from Nash Road, site 93, Wheatfield, N.Y., June 24, 1982.............. 204

B-10. Analyses of substrate samples from R. P. Adams Co., site 103, Tonawanda, N.Y., August 11, 1982...................... 209

B-11. Analyses of substrate samples from Allied Chemical, site 105, Tonawanda, N.Y...................................... 211

B-12. Analyses of soil samples from Allied Chemical, site 106, Tonawanda, N.Y.. 214

TABLES (continued)

Page

Table B-13. Analyses of ground-water, surface-water, and substrate samples from Tonawanda Coke, site 108, Tonawanda, N.Y....... 216

B-14. Analyses of surface-water, ground-water and substrate samples from Tonawanda Coke, site 109, Tonawanda, N.Y............... 219

B-15. Analyses of substrate samples from Tonawanda Coke, site 110, Tonawanda, N.Y., May 24, 1983.............................. 223

B-16. Analyses of substrate samples from Aluminum Match Plate, site 111, Tonawanda, N.Y., July 20, 1982.................... 226

B-17. Total polychlorinated biphenyl concentration in soil samples from Columbus McKinnon Corporation, site 123, Tonawanda, N.Y. 229

B-18. Concentrations of total halogenated organic compounds (THO) in soil samples from Columbus McKinnon Corporation, site 123, Tonawanda, N.Y.. 230

B-19. Concentration of polychlorinated biphenyls and total halogenated organic compounds in soil samples from Columbus McKinnon Corporation, site 123, Tonawanda, N.Y............. 230

B-20. Analyses of soil samples from Dunlop Tire and Rubber Company, sites 125, 126, and 127, Tonawanda, N.Y., July 1982......... 232

B-21. Analyses of ground-water samples from Dupont Company, site 128, Tonawanda, N.Y., August 18, 1982................. 237

B-22. Analyses of substrate samples from FMC, site 131, Sawyer Street, Tonawanda, N.Y.................................... 241

B-23. Analyses of substrate samples from INS Equipment Corporation, site 136, Tonawanda, N.Y., August 10, 1982..... 245

B-24. Analyses of substrate samples from Pennwalt-Lucidol Division, site 137, Tonawanda, N.Y., July 30, 1982.......... 249

B-25. Analyses of substrate sample at 6-ft depth from Roblin Steel, site 149, Tonawanda, N.Y., August 10, 1982................. 251

B-26. Analyses of substrate samples from Shanco Plastics, sites 150 and 151, Tonawanda, N.Y., May 31, 1983................. 253

B-27. Permeability coefficients from test borings at Spaulding Fibre Company, sites 154 and 155, Tonawanda, N.Y............ 256

B-28. Analyses of water from monitoring wells at Spaulding Fibre Company, site 154, Tonawanda, N.Y.......................... 258

TABLES (continued)

Page

Table B-29. Analyses of substrate samples from Spaulding Fibre, site 155, Tonawanda, N.Y., July 21, 1982 259

B-30. Analyses of substrate samples from J. H. Williams, site 160, Tonawanda, N.Y., July 29, 1982 261

B-31. Analyses of ground-water samples from Chemical Leaman Tank Lines, site 167, Tonawanda, N.Y., July 19, 1982 262

B-32. Analyses of substrate samples from Huntley Power Station, site 182, Tonawanda, N.Y 269

B-33. Analyses of substrate samples from William Strassman Property, site 204, Tonawanda, N.Y., May 24, 1983 278

B-34. Analyses of leachate from City of Tonawanda Landfill, site 207, Tonawanda, N.Y., 1980-81 281

B-35. Analyses of ground-water, surface-water, and substrate samples from City of Tonawanda Landfill, site 207, Tonawanda, N.Y., July-August 1982 282

B-36. Analyses of ground-water samples from Botanical Gardens, site 243, North Tonawanda, N.Y., June 18, 1982 286

B-37. Analyses of ground-water, and substrate samples from Creekside Golf Course, site 252, Amherst, N.Y., August 25, 1982 288

Niagara Falls Area

C-1. Analyses of substrate samples from Airco Speer Carbon-Graphite, site 2, Wheatfield, N.Y 292

C-2. Analyses of substrate samples from Basic Carbon, site 4, Niagara Falls, N.Y., May 26, 1983 294

C-3. Analyses of substrate samples from Bell Aerospace Textron, site 5, Wheatfield, N.Y., July 1, 1982 296

C-4. Phenol concentrations in ground-water samples from Carborundum Abrasive Division, site 9, Wheatfield, N.Y., 1981 300

C-5. Analyses of substrate samples from Chisholm Ryder, site 11, Niagara Falls, N.Y 302

C-6. Analyses of ground-water samples from Lockport Dolomite at Dupont, Necco Park, site 14, Niagara Falls, N.Y., June 25, 1982 306

TABLES (continued)

Page

Table C-7. Analyses of substrate samples from Frontier Bronze, site 21, Niagara Falls, N.Y. 310

C-8. Analyses of surface-water and substrate samples from Great Lakes Carbon, site 22, Niagara Falls, N.Y., June 28, 1982... 312

C-9. Chemical data from well 77A in the southwest part of site 38.... 317

C-10. Type of chemical wastes deposited at the Occidental Chemical-Hyde Park Landfill, site 39, Niagara Falls, N.Y., 1953-79... 319

C-11. Permeability of overburden at Occidental Chemical-Hyde Park Landfill, site 39, Niagara Falls, N.Y. 323

C-12. Results of permeability tests at Occidental Chemical, Buffalo Avenue Plant, sites 41b-49, Niagara Falls, N.Y., January 7-8, 1980.... 337

C-13. U.S. Geological Survey analyses of substrate samples from Olin parking lot and Olin mercury ponds, sites 58, 59, and 248, Niagara Falls, N.Y., August 9, 1982.... 349

C-14. Site owner's analyses of substrate split samples from Olin parking lot and Olin mercury ponds, sites 58, 59, and 248, Niagara Falls, N.Y., August 9, 1982.... 350

C-15. Analyses of ground-water samples from Union Carbide, site 64, Niagara Falls, N.Y., August 29, 1982.... 354

C-16. Analyses of ground water from Reichhold Varcum Chemical Division, site 66, Niagara Falls, N.Y., June-July 1982...... 357

C-17. Analyses of substrate samples from Lynch Park, site 76, Wheatfield, N.Y., June 19, 1982.... 359

C-18. Analyses of ground-water samples from Modern Disposal, site 77, Model City, N.Y., August 19, 1982.... 360

C-19. Analyses of ground-water and substrate samples from Niagara County Refuse Disposal, site 81, Wheatfield, N.Y., June-August 1982.... 369

C-20. Analyses of surface water and bottom samples taken from drainage ditches at Niagara County Refuse Disposal, site 81, Wheatfield, N.Y. 371

C-21. Analyses of substrate samples from Adams Generating Plant, site 82, Niagara Falls, N.Y., July 27, 1982.... 378

TABLES (continued)

Page

Table C-22. Analyses of substrate samples from Buffalo Avenue, site 83, Niagara Falls, N.Y. 381

C-23. Analyses of ground-water and substrate samples from Cayuga Island, site 84, Niagara Falls, N.Y. 384

C-24. Analyses of ground-water and substrate samples from Griffon Park, site 85, Niagara Falls, N.Y., July 12, 1982 386

C-25. Analyses of ground-water sample from the Hydraulic Canal, site 86, Niagara Falls, N.Y., January 14, 1983 390

C-26. Analyses of ground-water samples from New Road, site 87, Niagara Falls, N.Y., July 8, 1982 392

C-27. Analyses of substrate samples from south site, 64th Street, site 88, Niagara Falls, N.Y., August 11, 1982 394

C-28. Analyses of substrate samples from north site, 64th Street, site 88, Niagara Falls, N.Y., August 11, 1982 395

C-29. Analyses of substrate samples from Whitmer Road, site 90, Niagara Falls, N.Y. 398

C-30. Analyses of substrate samples from Niagara Frontier Transportation Authority, site 92, Wheatfield, N.Y., July 27, 1982 401

C-31. Analyses of ground-water samples from Niagara River-Belden site, site 94, Wheatfield, N.Y., June 26, 1982 403

C-32. Analyses of surface-water samples from Old Creek Bed, (Dibacco), site 95, Niagara Falls, N.Y., July 9, 1982 405

C-33. Analyses of substrate samples from Silbergeld Junk Yard, site 100, Niagara Falls, N.Y., July 8, 1982 409

C-34. Analyses of substrate samples from Rodeway Inn, site 237, Niagara Falls, N.Y. 411

C-35. Analyses of substrate samples from St. Mary's School, site 238, Niagara Falls, N.Y. 413

C-36. Analyses of substrate and ground-water samples from 97th Street Methodist Church, site 245, Niagara Falls, N.Y., August 27, 1982 417

C-37. Analyses of ground water samples from Solvent Chemical, site 251, Niagara Falls, N.Y., July-August 1980 421

C-38. Analyses of substrate samples from Stauffer Chemical, site 255, Lewiston, N.Y., August 12, 1982 424

CONVERSION FACTORS AND ABBREVIATIONS

Factors for converting inch-pound units used in this report to International System (SI) units are shown below.

To convert inch-pound unit	Multiply by	To obtain SI unit
	Length	
inch (in)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square foot (ft^2)	0.0929	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	0.4047	hectare (ha)
	Volume	
cubic yard (yd^3)	0.76456	cubic meter (m^3)
gallon (gal)	3.7854	liter (L)
	Flow	
million gallons per day (Mgal/d)	3785.434	cubic meters per day (m^3/d)
	Weight to mass	
pound (lb)	453.6	grams (g)
ton	907.2	kilograms (kg)
	Concentration	
parts per million	approximately 1	milligrams per liter
parts per billion (ppb)	approximately 1	micrograms per kilogram µg/kg)
parts per billion (ppb)	approximately 1	micrograms per liter (µg/L)
micromhos per centimeter at 25°C (µmho/cm at 25°C) ±2% of value for ±1°C	540 to 960	micrograms per liter (µg/L)
	Slope	
feet per mile (ft/mi)	0.490	meters per kilometer (m/km)

Datum

NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD)--Formerly called SEA LEVEL DATUM 1929. A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada. In the adjustment, sea levels from selected TIDE stations in both countries were held as fixed. The year indicates the time of the last general adjustment. This datum should not be confused with MEAN SEA LEVEL.

Disclaimer

Use of trade names herein is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

LIST OF SITES STUDIED

Page

Buffalo Area (Appendix A)

Allied Chemical, site 107, NYSDEC 915004 92
Anaconda, site 113, NYSDEC 915007. 93
Bethlehem Steel, site 118, NYSDEC 915009 97
Buffalo Color, sites 120-122, NYSDEC 915012-a,b,c. 101
Fedders Automotive Component Company, site 132, NYSDEC 915024. 104
Hanna Furnace, site 135, NYSDEC 915029 104
McNaughton Brooks, site 138, NYSDEC 915034 107
Houdaille Industries-Manzel Division, site 140, NYSDEC 915037. 111
Mobil Oil, site 141, NYSDEC 915040 114
Mollenberg-Betz, site 142, NYSDEC 915041 117
Otis Elevator, site 144, NYSDEC 915073 118
Pratt and Letchworth, site 146, NYSDEC 915045. 119
Ramco Steel, site 147, NYSDEC 915046 120
Republic Steel, site 148, NYSDEC 915047. 122
Alltift Landfill, site 162, NYSDEC 915054. 126
Empire Waste, site 173, NYSDEC 915065. 132
Hopkins Street, site 180, NYSDEC 915011. 134
Kelly Island, site 184, NYSDEC 915095. 134
Lehigh Valley Railroad, site 190, NYSDEC 915781. 135
Niagara Frontier Port Authority, site 196, NYSDEC 915026 140
Procknal & Katra, site 200, NYSDEC 915085. 142
Squaw Island, site 203, NYSDEC 915052. 145
Tifft Farm, site 206, NYSDEC 915072. 150
Erie Basin Marina, site 216, NYSDEC 915013 150
Donner Hanna Coke, site 217, NYSDEC 915017 150
Hartwell Street Landfill, site 219, NYSDEC 915030. 155
West Seneca Transfer Station, site 220, NYSDEC 915039. 155
Times Beach Containment Site, site 241, NYSDEC 915080. 157
Allied Chemical, Hurwitz-Ranne, site 249, NYSDEC 915120. 163
Small Boat Harbor Containment Site, site 253 167
Buffalo Harbor Containment Site, site 254. 170

Tonawanda Area (Appendix B)

Buffalo Pumps Division, site 6, NYSDEC 932044. 176
Occidental Chemical-Durez Division, sites 24-37, NYSDEC 93218. 178
National Grinding Wheel, site 50, NYSDEC 932066. 183
Roblin Steel Company, site 60, NYSDEC 932059 186
Frontier Chemical-Pendelton, site 67, NYSDEC 932043. 187
Gratwick, site 68, NYSDEC 932060 190
Holiday Park, site 72. 194
Nash Road, site 93, NYSDEC 932054. 200
R. P. Adams, site 103, NYSDEC 915001 208
Allied Chemical, Tonawanda, site 105, NYSDEC 915003-b. 210
Allied Chemical, Tonawanda, site 106, NYSDEC 915003-c. 213
Tonawanda Coke, site 108, NYSDEC 915055-a. 214
Tonawanda Coke, site 109, NYSDEC 915055-b. 218
Tonawanda Coke, site 110, NYSDEC 915055-c. 222

LIST OF SITES STUDIED (continued)

Tonawanda area (continued)

Page

Aluminum Match Plate, site 111, NYSDEC 915055. 224
Ashland Petroleum, site 114, NYSDEC 915061 226
Ashland Petroleum, site 115, NYSDEC 915008-c 226
Ashland Petroleum, site 116, NYSDEC 915008-a 227
Ashland Petroleum, site 117, NYSDEC 915008-b 227
Columbus McKinnon, site 123, NYSDEC 915016 228
Dunlop Tire and Rubber Company, sites 125-127, NYSDEC 915018-a,b,c . . . 231
Dupont Company, site 128 235
Exolon Corporation, site 130, NYSDEC 915023. 239
FMC Corporation, site 131, NYSDEC 915025 239
INS Equipment Corporation, site 136. 243
Pennwalt-Lucidol Division, site 137, NYSDEC 915035 248
O-Cel-O, site 143. 250
Roblin Steel, site 149, NYSDEC 915036. 250
Shanco Plastics, sites 150-151, NYSDEC 915048. 251
Spaulding Fibre, sites 153-155-a,b, NYSDEC 915050-a,d. 254
Union Carbide, site 158. 250
J. H. Williams, site 160, NYSDEC 915057. 260
Chemical Leaman, site 167, NYSDEC 915014 262
Huntley Power Station, site 182, NYSDEC 915063 263
Seaway Industrial Park, site 201, NYSDEC 915074. 275
William Strassman, site 204, NYSDEC 915083 277
City of Tonawanda Landfill, site 207, NYSDEC 915079. 279
Veteran's Park, site 208, NYSDEC 915078. 284
Air Force Plant no. 40, site 211, NYSDEC 915067. 284
Botanical Gardens, site 243, NYSDEC 932068 284
Creekside Golf Course, site 252, NYSDEC 915123 286

Niagara Falls Area (Appendix C)

Airco Alloys, site 1, NYSDEC 932001. 290
Airco Speer Carbon-Graphite, site 2, NYSDEC 932002 290
Basic Carbon Co., site 4, NYSDEC 932004. 293
Bell Aerospace, site 5, NYSDEC 932052. 295
Carborundum, Bldg. 89, site 7, NYSDEC 932048-a 297
Carborundum, Bldg. 82, site 8, NYSDEC 932048-b 298
Carborundum, Abrasive Division, site 9, NYSDEC 932007. 298
Carborundum, Globar Plant, site 10, NYSDEC 932036. 300
Chisholm Ryder, site 11, NYSDEC 932009 300
Dupont, Necco Park, site 14, NYSDEC 932047 304
Dupont, Buffalo Avenue, sites 15, 19, 250, NYSDEC 932013a-f. 308
Frontier Bronze, site 21, NYSDEC 932015. 309
Great Lakes Carbon, site 22, NYSDEC 932016 311
Occidental-Love Canal, site 38, NYSDEC 932020. 313
Occidental-Hyde Park, site 39, NYSDEC 932021 318
Occidental-102d Street, site 40, NYSDEC 932022 324
Occidental Area, site 41a, NYSDEC 932019-a 325
Occidental-Buffalo Avenue Plant, sites 41b-49, NYSDEC 932019b-c. 332

LIST OF SITES STUDIED (continued)

Niagara Falls area (continued)

Page

TAM Ceramics, site 51, NYSDEC 932028 337
Olin-102d Street Landfill, site 56, NYSDEC 932031. 339
Olin-Industrial Welding, site 57, NYSDEC 932050. 342
Olin-Buffalo Avenue, sites 58, 59, 248, NYSDEC 932051-a,b, 932038. . . . 346
Stauffer Chemical, North Love Canal, site 62, NYSDEC 932034. 351
Stauffer-Art Park, site 63, NYSDEC 932049. 351
Union Carbide, site 64, NYSDEC 932035. 353
Reichhold-Varcum, site 66, NYSDEC 932040 354
La Salle Expressway, site 73, NYSDEC 932067. 357
Lynch Park, site 76, NYSDEC 932006 358
Modern Disposal Services, site 77, NYSDEC 932025 360
Cecos and Niagara Recycling, sites 78a, 78b, NYSDEC 932046, 932042 . . . 361
Power Authority Road Site, site 79, NYSDEC 952091. 367
Niagara County Refuse Disposal, site 81, NYSDEC 932026 367
Adams Generating Plant, site 82, NYSDEC 932079 376
Buffalo Avenue, site 83, NYSDEC 932080 379
Cayuga Island, site 84, NYSDEC 932008. 383
Griffon Park, site 85, NYSDEC 932081 385
Hydraulic Canal, site 86, NYSDEC 932082. 390
New Road, site 87, NYSDEC 932083 391
64th Street, site 88, NYSDEC 932085. 393
Whirlpool Site, site 89, NYSDEC 932088 396
Witmer Road, site 90, NYSDEC 932027. 397
Town of Niagara Landfill, site 91, NYSDEC 932089 399
Niagara Falls Transportation Authority, site 92, NYSDEC 932090 399
Niagara River, Belden, site 94, NYSDEC 932055. 401
Old Creek Bed, Dibacco, site 95, NYSDEC 932056-a 404
Robert Moses Parkway, site 96, NYSDEC 932067 408
Silbergeld Junk Yard, site 100, NYSDEC 932093. 408
Rodeway Inn, site 237, NYSDEC 932086 410
St. Marys School, site 238, NYSDEC 932087. 412
Charles Gibson Site, site 242, NYSDEC 932063 414
93rd Street School, site 244, NYSDEC 932078. 415
97th Street Methodist Church, site 245, NYSDEC 932084. 416
Olin Deep Well, site 247, NYSDEC 932037. 418
Solvent Chemical, site 251 418
Stauffer-Power Authority of State of New York, site 255,
NYSDEC 932053. 422

Preliminary Evaluation of Chemical Migration To Groundwater and the Niagara River From Selected Waste-Disposal Sites

by

Edward J. Koszalka, James E. Paschal, Jr.,
Todd S. Miller, and Philip B. Duran

ABSTRACT

In 1982, the U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation, made a preliminary hydrogeologic and chemical evaluation of 138 known toxic waste-disposal sites along the United States side of the Niagara River from Lake Erie to Lewiston, approximately 20 miles downstream. The purpose of the investigation was to identify sites that are a possible source of contamination to the ground-water system.

The 138 sites were grouped into three areas--Buffalo, Tonawanda, and Niagara Falls. Results from the geologic and hydrologic investigations and chemical analyses are as follows:

Buffalo area.--25 sites were studied, of which 19 were drilled and sampled, and 6 evaluated through a literature review. Of the 25 sites, 10 were designated as having a major potential for contaminant migration.

Tonawanda area.--50 sites were studied, of which 29 were drilled and sampled, and 21 evaluated through a literature review. Of the 50 sites, 20 were designated as having a major potential for chemical migration.

Niagara Falls area.--63 sites were studied, of which 31 were drilled and sampled, and 32 evaluated through a literature review. Of the 63 sites, 31 were designated as having a major potential for contaminant migration.

INTRODUCTION

United States and Canadian monitoring of the Niagara River, which flows 37 miles north from Lake Erie to Lake Ontario, has indicated the presence of contamination. A report issued in March 1979 by an Interagency Task Force on Hazardous Waste, composed of representatives of the New York State Department of Environnmental Conservation, the New York State Department of Health, and the U.S. Environmental Protection Agency, identified 215 hazardous waste-disposal sites in Erie and Niagara,Counties. Of these and additional sites identified since 1979, 164 are within a strip 3 miles wide along the east bank of the Niagara River (fig. 1). The possibility that toxic substances from these sites could migrate to the ground-water system and from there to the Niagara River and into Lake Ontario has become of increasing concern in recent years.

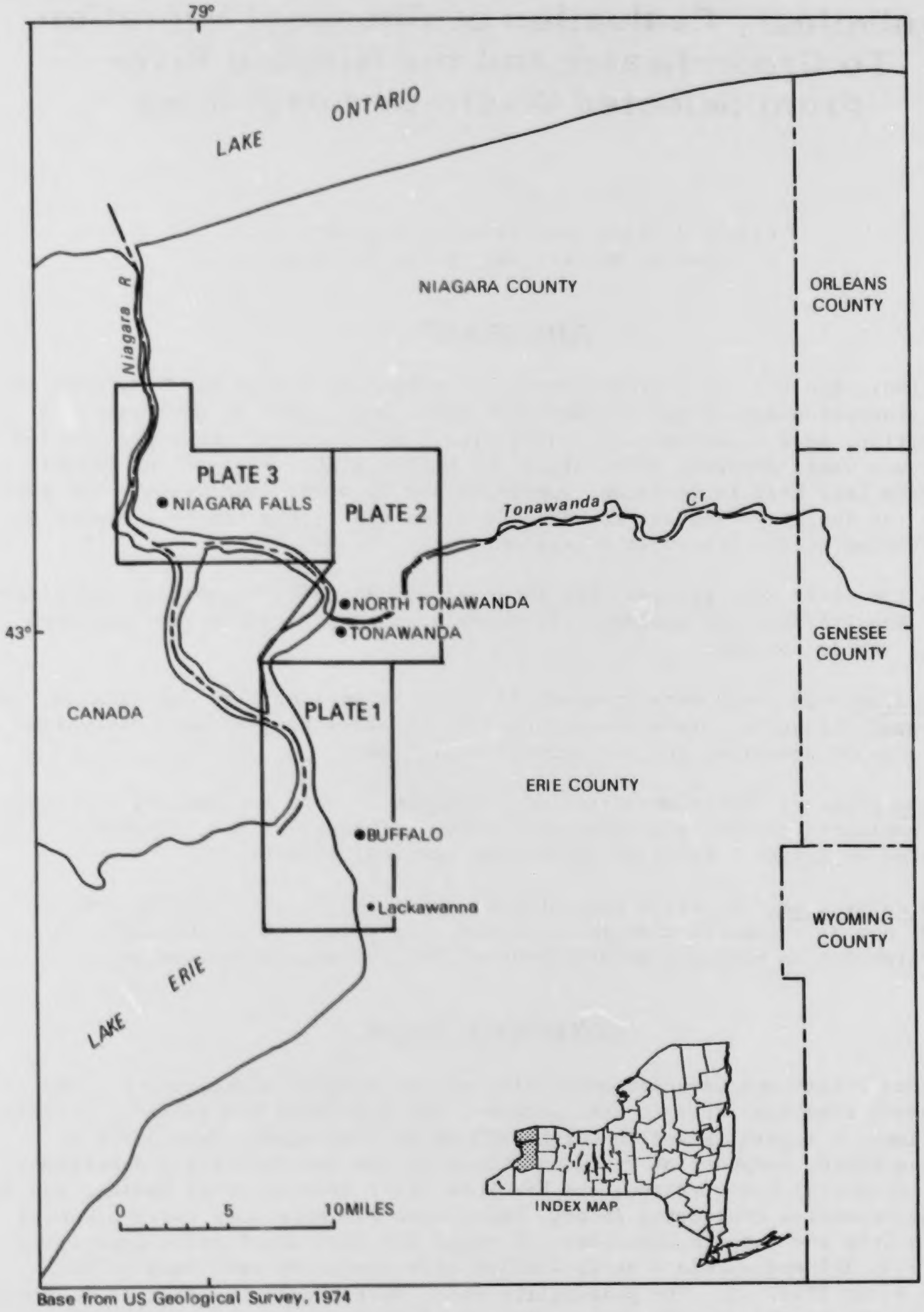

Figure 1. Location of study area in Erie and Niagara Counties.

Effective remedial action requires information on the hydrogeology and the potential for migration of contaminants into the ground water.

Purpose and Scope

In 1982, the U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC), began a preliminary hydrogeologic evaluation of 138 of the 164 known toxic waste-disposal sites along the Niagara River from Lake Erie to Lake Ontario, on the United States side of the river. The main objectives of the investigation were to evaluate the hydrogeology and potential for chemical migration to ground water at the 138 sites. Test drilling and core analysis were done at selected sites to obtain information on the composition of the overburden, and ground-water and core samples were collected and analyzed to identify the substances present and their concentration. The location and extent of the disposal area at some sites were unknown; therefore, some wells and test holes may not have been installed at the most significant locations.

The project was limited to preliminary investigations only and was not designed to assess the actual effect of ground-water contamination on the Niagara River nor to establish whether contaminant migration has actually occurred.

This report presents the hydrologic and chemical data collected during the investigation, describes the probable ground-water flow patterns as inferred from the available data, and categorizes each site in terms of its potential for contaminant migration. It also contains suggestions for future studies to evaluate the regional effects of contaminant migration on the Niagara River.

Acknowledgments

This report was done in cooperation with the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation. The authors express special thanks to NYSDEC, Region 9, particularly John McMahon, Peter Buechi, and their technical staff, for assistance during the field investigations and for report review. Thanks are also extended to the members of USEPA Great Lakes National Program Office (GLNPO) and Region II. Appreciation is extended to Vacys Saulys (GLNPO) and to Rolland Hemmett and Gerard McKenna of USEPA, Region II, for technical guidance and report review.

Thanks are also extended to Donald Campbell of Erie County Department of Environment and Planning, and Michael Hopkins of Niagara County Health Department, for help in the field investigation of several sites and for their review of this report.

Thanks are also extended to the contract drillers.

METHODS OF INVESTIGATION

The region was divided on the basis of disposal-site density into three areas--Buffalo, Tonawanda, and Niagara Falls (fig. 1). The Buffalo area (pl. 1) extends from Lackawanna to the northern boundary of the city of Buffalo; most of the sites are concentrated in the southern part of Buffalo. The Tonawanda area (pl. 2) begins at the northern boundary of Buffalo and extends to the western boundary of the city of North Tonawanda; in this area the sites are distributed evenly. The Niagara Falls area (pl. 3) extends from the western boundary of North Tonawanda to the mouth of the Niagara River; most sites in this area are concentrated within the city of Niagara Falls.

Prior to this study, consultants had done subsurface hydrogeologic and chemical-contaminant investigations at 59 of the 164 sites. The consultant reports were reviewed in this study, but those sites were not included in the 1982 field investigation. Another 26 sites were omitted from the field studies because NYSDEC reported that they did not warrant an investigation, either because the materials deposited were not considered hazardous or because the site location could not be determined. The remaining 79 sites required subsurface hydrogeologic investigations and chemical analyses to identify which sites are possible sources of ground-water contamination.

During the summer of 1982, the U.S. Geological Survey did test drilling and core sampling at the 79 latter sites and collected ground-water samples and(or) samples of unconsolidated materials for interpretation of contaminant migration. Electromagnetic surveys were done at several sites at which the extent of the disposal area was uncertain to help define the extent of leachate plumes or locate the boundaries of fill areas. The number of sites in each area and the type of investigations done are summarized below. The site names, site numbers, and potential for ground-water contamination are given in the individual site descriptions in appendices.

	Number of sites			
Area	Field investigations	Literature review only	Investigations not needed (as determined by NYSDEC)	Total
Buffalo	19	6	8	33
Tonawanda	29	21	10	60
Niagara Falls	31	32	8	71
TOTAL	79	59	26	164

Several tasks, needed to achieve the objectives of the study are described below.

Individual Site Studies

Assignment of Site Numbers

Each site has been assigned two numbers. The first is a site-designation number from 1 to 254 given by the New York State Department of Environmental

Conservation (NYSDEC) as a local identifier in Erie and Niagara Counties. The second is a six-digit NYSDEC registration number for regional and county identification. The short number is used throughout the text and on the plates for identification; the six-digit number is given at the beginning of each site description in the appendices for reference.

Literature Review

Geohydrologic and chemical data provided by the USEPA, NYSDEC, USGS, consultants to the site owner, or the site operator were used for a preliminary evaluation of 59 sites to determine their potential for contaminant migration. Site evaluations based on these sources are included among the site descriptions in the appendices.

Drilling and Coring

Test holes were drilled in the overburden of the deposition area at each of the 79 sites previously identified as containing hazardous waste to assess the potential for contaminant migration. These holes were drilled by a truck-mounted auger rig. The depth of the holes varied, depending upon the thickness of a saturated zone (if encountered), the presence of a tight confining unit, the depth of known waste burial, or the depth determined necessary to describe hydrogeologic conditions at the site.

Core samples were collected where possible to delineate the site geology and zones of potential contaminant migration. A monitoring well was installed in each test hole that intersected the water table to obtain a water sample. Wells consisted of a 1.5-in O.D. black iron casing with a 1.25-in-diam. 2-ft-long slotted black iron screen. At sites where the water table was not encountered, a substrate sample was collected in a zone of potential contaminant migration. Geologic logs of the test borings are included in the site descriptions.

Substrate and Water Sampling

Ground water, surface water, and(or) substrates were sampled on the 79 sites. (The term substrates, as used here, means any unconsolidated materials such as soil, sediment, till, or artificial fill.) All sampling was done according to a quality-assurance/quality-control plan acceptable to the NYSDEC, USEPA, and USGS. The methods used to collect samples, the quality-control procedures, and the results of quality-control analysis are described at the end of this section.

The heavy metals and(or) organic compounds to be analyzed in each sample were selected by NYSDEC. Selection was based upon knowledge of buried chemicals and records of disposal operations. Substrate samples were analyzed only for acid-leachable metals (not total); water samples were analyzed for total recover-able metals and for organic compounds. Surface-water samples were collected from onsite streams or adjacent drainage ditches. The number of test holes drilled, number of samples collected, and the chemical constituents and compounds analyzed are listed in table 1.

Table 1.--Substrate and water-sample data, 1982-83.

(Site locations are shown in plates 1-3.)

			Number of test holes drilled	Number of previous wells	Number of water samples		Number of substrate samples	Type of analysis and number of samples analyzed													
Site name	Site number	Sampling date			Ground water	Surface water		GC/MS Extractables	Volatiles	As	Cd	Cr	Cu	Fe	Pb	Hg	Ni	V	Zn	CN	S
Buffalo Area																					
Hanna Furnace	035	08-02-82	7	-	-	-	8	-	-	-	-	8	8	8	8	-	-	-	-	-	-
Allied Chemical	107	07-19-82	-	3	3	-	-	-	-	-	-	3	3	3	3	-	3	3	-	-	3
Anaconda	113	07-28-82	4	-	-	-	4	4	-	4	4	4	4	4	4	4	4	-	4	-	-
		05-29-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
McNaughton Brooks	138	08-05-82	4	-	-	-	4	4	-	-	4	4	-	4	4	-	-	-	-	-	-
Houdaille-Manzel			4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Division	140	08-06-82	4	-	-	-	4	4	-	-	-	-	4	4	4	-	4	-	-	-	-
		05-20-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Mobil Oil	141	08-06-82	4	-	-	-	4	4	-	-	-	-	-	4	4	-	-	-	-	-	-
		05-20-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Otis Elevator	144	08-30-82	8	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Ramco Steel	147	07-22-82	3	-	-	2	4	-	-	-	-	6	6	6	6	-	-	-	-	-	-
Republic Steel [1]	148	07-22-82	-	7	6	1	-	7	-	7	7	7	7	7	7	7	7	7	7	-	-
Empire Waste	173	07-30-82	4	-	-	-	4	-	-	4	4	4	4	4	4	4	-	-	4	-	-
Lehigh Valley Railroad	190	07-19-82	20	-	-	-	20	-	-	-	20	20	20	20	20	-	20	-	-	-	-
Niagara Frontier Port Authority	196	08-05-82	4	-	-	-	4	-	-	-	4	4	4	4	4	-	4	-	-	-	-
Squaw Island	203	07-29-82	8	-	-	-	8	8	-	-	-	6	6	6	-	-	-	-	-	-	-
		05-18-83	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Donner Hanna Coke	217	08-05-82	4	-	-	-	4	4	-	-	-	-	-	4	-	-	-	-	-	4	-
		05-18-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
West Seneca Transfer Station	220	08-26-82	4	-	-	-	5	5	-	5	5	5	5	5	5	5	5	-	-	-	-
Times Beach	241	01-11-83	3	-	3	1	-	4	4	4	4	4	4	4	4	4	4	4	4	-	-
Containment Site[1]																					
llied Chemical (Hurwitz-Ranne) Hopkins Street	249	08-11-82	6	-	-	-	7	-	-	-	-	7	-	7	-	-	-	-	-	-	-
		05-18-83	6	-	-	-	6	6	6	-	-	-	-	-	-	-	-	-	-	-	-
Small Boat Harbor Containment Site[1]	253	01-11-83	3	-	3	1	-	4	4	4	4	4	4	4	4	4	4	4	4	-	-
Buffalo Harbor Containment Site[1]	254	01-10-83	3	-	3	1	-	4	4	4	4	4	4	4	4	4	4	4	4	-	-
Buffalo area totals	19 sites		121	10	18	6	109	81	40	32	60	90	83	102	85	32	59	22	27	4	3

[1] Also analyzed for aluminum, antimony, barium, beryllium, boron, cobalt, manganese, selenium, silver, thallium, and tin.

Table 1.--Substrate and water-sample data, 1982-83 (continued)

(Site locations are shown in plates 1-3.)

Site name	Site number	Sampling date	Number of test holes drilled	Number of previous wells	Number of water samples		Number of substrate samples	Type of analysis and number of samples analyzed													
					Ground water	Surface water		GC/MS Extractables	Volatiles	As	Cd	Cr	Cu	Fe	Pb	Hg	Ni	V	Zn	CN	S
Tonawanda Area																					
Buffalo Pumps Division	006	06-21-82	2	-	2	-	1	3	-	-	-	3	3	3	-	-	-	-	-	-	-
Frontier Chemical-Pendleton Site	067	06-22-82	3	-	2	2	2	-	-	-	6	6	6	6	-	-	6	-	6	-	-
		05-23-83	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Gratwick-Riverside Park	068	07-28-82	-	5	5	-	-	5	5	5	5	5	5	5	5	5	5	-	-	-	-
Holiday Park	072	06-19-82	7	-	7	4	1	12	-	-	-	-	12	12	-	-	-	-	-	-	-
Nash Road	093	06-24-82	4	-	2	-	4	6	-	6	6	6	6	6	6	6	6	-	-	-	-
R. P. Adams Company	103	08-11-82	4	-	-	-	4	4	-	-	-	-	-	4	4	-	-	-	-	-	-
Allied Chemical, Tonawanda	105	07-20-82	4	-	-	-	4	4	-	4	4	4	-	4	4	4	4	-	-	-	-
		05-19-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Tonawanda Coke	108	07-13-82	3	-	1	1	2	4	-	-	-	-	-	4	-	-	-	-	-	4	-
		05-24-83	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Tonawanda Coke	109	07-14-82	1	-	1	1	-	2	1	2	2	2	2	2	2	2	2	2	2	-	-
		05-24-83	3	-	-	-	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Tonawanda Coke	110	05-24-83	3	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum Match Plate	111	07-20-82	4	-	-	-	4	4	-	-	-	-	-	4	-	4	-	-	-	-	-
Dunlop Tire & Rubber	125-27	07-09-82	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Dupont Company	128	08-18-82	-	4	5	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-
FMC Corporation	131	08-04-82	4	-	-	-	4	4	-	-	-	-	-	4	-	-	-	-	4	-	-
		08-19-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
INS Equipment Corp.	136	08-10-82	10	-	-	-	10	10	-	-	10	10	-	10	10	-	-	-	-	-	-
Pennwalt-Lucidol Division	137	07-30-82	4	-	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Roblin Steel Company	149	08-10-82	1	-	-	-	1	-	-	1	1	1	1	1	1	1	-	-	1	-	-
Shanco Plastics	150-51	05-31-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Spaulding Fibre	155	07-21-82	4	-	-	-	4	-	-	-	-	-	-	3	-	-	-	-	3	-	-
J. H. Williams Company	160	07-19-82	4	-	-	-	4	4	-	-	-	-	-	4	4	-	-	-	-	-	-
Chemical Leaman Tank Lines	167	07-19-82	-	3	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Huntley Power Station	182	07-15-82	13	-	-	2	18	-	-	20	20	20	-	20	20	20	20	-	-	-	-
		05-21-83	16	-	-	-	20	20	20	-	-	-	-	-	-	-	-	-	-	-	-
William Strassman Property	204	05-24-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
City of Tonawanda Landfill	207	07- -83	8	-	2	2	8	10	-	-	-	10	-	10	-	-	-	-	-	-	-
Botanical Gardens	243	06-19-82	-	2	3	-	-	3	-	-	-	-	3	3	-	-	-	-	-	-	-
Creekside Golf Course	252	08-25-82	3	-	2	-	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-
Tonawanda area totals		29 sites	129	14	35	12	129	143	57	38	54	67	38	105	56	42	43	2	16	4	0
Niagara Falls Area																					
Airco Speer Carbon-Graphite	002	07-14-82	4	-	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-
		05-27-83	3	-	-	-	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Basic Carbon Company	004	05-26-83	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Bell Aerospace Textron	005	06-01-82	2	-	-	-	2	-	-	-	2	2	2	2	-	-	-	-	-	-	-
Chisholm Ryder	011	06-30-82	3	-	-	-	3	3	-	-	3	3	3	3	3	3	-	-	3	-	-
		05-25-83	3	-	-	-	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-

Table 1.--Substrate and water-sample data, 1982-83 (continued)

(Site locations are shown in plates 1-3.)

Site name	Site number	Sampling date	Number of test holes drilled	Number of previous wells	Number of water samples		Number of substrate samples	Type of analysis and number of samples analyzed													
					Ground water	Surface water		GC/MS Extractables	Volatiles	As	Cd	Cr	Cu	Fe	Pb	Hg	Ni	V	Zn	CN	S
Niagara Falls Area (continued)																					
Frontier Bronze	021	07-08-82	2	-	-	-	2	2	-	-	-	-	2	2	-	-	-	-	-	-	-
		05-26-82	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Great Lakes Carbon	022	06-28-82	3	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Olin, Buffalo Avenue	058,59, 248	08-09-82	10	-	-	-	11	11	-	-	-	-	-	11	-	11	-	-	-	-	-
Art Park	063	07- -82	3	-	-	1	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Union Carbide	064	08-29-82	-	2	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Lynch Park	076	06-19-82	3	-	-	-	3	3	-	-	-	-	3	3	-	3	-	-	-	-	-
Modern Disposal Services	077	08-19-82	-	2	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Niagara County Refuse Disposal Site	081	06- -82	11	-	3	-	6	9	-	-	-	-	-	-	-	-	-	-	-	-	-
Adams Generating Plant	082	07-27-82	4	-	-	-	4	4	-	-	-	4	4	4	-	4	-	-	-	-	-
		05-28-83	4	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Buffalo Avenue	083	06-25-82	9	-	-	-	12	12	-	-	-	-	-	12	-	12	-	-	-	-	-
		05-28-83	6	-	-	-	6	6	6	-	-	-	-	-	-	-	-	-	-	-	-
Cayuga Island	084	01-12-83	1	-	1	-	-	1	-	-	1	1	1	1	1	-	-	-	1	-	-
		05-28-83	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Griffon Park	085	07-12-82	4	-	1	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Canal	086	01-14-83	1	-	1	-	-	1	-	-	-	-	1	1	-	-	-	-	-	-	-
New Road Site [1]	087	07-08-82	-	3	3	-	-	3	-	3	3	3	3	3	3	3	3	3	3	-	-
64th Street Site	088	08-11-82	4	-	-	-	4	4	-	-	-	-	-	4	-	4	-	-	-	-	-
		05-29-83	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Whirlpool Site	089	82	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Witmer Road Site	090	06-29-82	2	-	-	-	2	2	-	-	-	-	2	2	-	2	-	-	-	-	-
		05-25-83	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Niagara Frontier Transportation Authority	092	07-27-82	2	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Niagara River Site (Belden)	094	06-26-82	2	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Old Creek Bed Dibacco[1]	095	07-09-82	-	-	-	4	-	2	2	2	2	2	2	2	2	2	2	2	2	-	-
Robert Moses Parkway	098		6	-	5	-	-	5	5												
Silbergeld Junk Yard	100	07-08-82	2	-	-	-	2	2	-	-	-	-	-	2	-	2	-	-	-	-	-
		05-27-83	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Rodeway Inn	237	06-29-82	2	-	-	-	2	2	-	-	-	-	-	2	-	2	-	-	-	-	-
		05-29-83	2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Saint Marys School	238	08-12-82	3	-	-	-	4	4	-	-	-	-	-	4	-	4	-	-	-	-	-
		05-29-83	3	-	-	-	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
97th Street Methodist Church	245	08-27-82	4	-	1	-	4	5	-	-	-	-	-	5	-	5	-	-	-	-	-
Stauffer Chemical-Power Authority State of New York	300	08-12-82	4	-	-	-	4	4	-	4	4	4	4	4	4	4	4	-	4	-	-
Niagara Falls area totals	31 sites		124	7	41	7	112	133	39	9	15	19	27	67	13	61	9	5	13	0	0
Totals for all areas	79 sites		374	31	88	25	350	357	136	79	129	176	148	274	154	135	111	29	56	8	3

Electromagnetic-Conductivity Survey

An electromagnetic conductivity survey was done on 21 of the 79 hazardous-waste sites to help delineate the areal extent of buried waste. The technique involved traversing the site on selected survey lines. A variation in observed values indicates changes in ground-water conductivity. The names and site numbers of the 21 sites investigated are:

Buffalo area: Donner Hanna Coke (217), Anaconda Brass Company (113)

Tonawanda area: Nash Road Landfill (93), Tonawanda Coke (108, 109, 110), Dunlop Tire and Rubber Company (125, 126, 127), Spaulding Fiber Company (153, 154, 155), Huntley-Power Station (182), City of Tonawanda Landfill (207)

Niagara Falls area: Dupont Necco Park (14), Olin Industrial Welding (57), Stauffer Power Authority (62), Art Park (63), Niagara County Refuse Disposal (81), Griffon Park (85), Cayuga Creek (242). The data and analyses of the surveys are given in the site descriptions in the appendices.

Study of Dredge-Spoil-Containment Sites

The Geological Survey studied three containment sites selected by USEPA along Lake Erie to determine the potential for migration of contaminated water from dredge-spoil containment sites to the Niagara River. The sites are the Times Beach containment site (site 241), the Small Boat Harbor containment site (site 253), and the Buffalo Harbor containment site (site 254), all in the Buffalo area (appendix A). Locations are shown in plate 1.

A nested piezometer was installed at each containment site. Each piezometer consisted of three wells screened at approximately 5, 10, and 15 ft below land surface. The deep well was screened at 15 ft or at the bottom of the fill material, whichever was less. Water samples were obtained from each well and from the ponds of each site and were analyzed for "priority pollutants."[1] The site descriptions, well-completion data, and chemical analyses are given in the Buffalo area site descriptions (appendix A).

A water-level recorder was installed at the Times Beach containment site to continuously measure water levels in the containment area. Lake-level data were obtained from automatic recorders at the U.S. Army Corps of Engineers station along the lake. This information was used to estimate the rate of flow from the containment area to Lake Erie.

Regional Hydrologic Investigation

Hydrogeology, Stratigraphy, and Water Quality

Eleven locations were chosen to help define the general hydrogeology and water quality in the three areas. (Locations are shown in pls. 1-3.) At each site a test hole was drilled to the top of bedrock by a conventional truck-mounted auger rig with hollow-stem augers. Where feasible, cores were collected at 5-ft intervals by a split-spoon assembly. These cores were used to describe the local geology.

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[1] USEPA priority pollutants are toxic constituents and compounds for which technology-based effluent limitations and guidelines are required by Federal law.

When bedrock was reached, a monitoring well with a 1.5-in.-diameter casing and a 2-ft-long, 1.25-in. diameter screen was installed. Where saturated thickness was 20 ft or more, two additional holes were drilled, and wells were installed at intermediate and shallow depths. The drilling method and well specifications were the same as for the deep monitoring wells. Where the saturated thickness was less than 20 ft, only one additional monitoring well was installed at a shallow depth. Each well was surveyed for elevation in reference to sea level.

A water sample was collected from the deepest well at nine of the 11 locations and was analyzed for USEPA priority pollutants (table 2). Water was evacuated from the casing three times by a peristaltic pump, and then the sample was collected with a stainless steel, Teflon-coated bailer.

Table 2.--U.S. Environmental Protection Agency list of recommended priority pollutants[1]

METALS

antimony
arsenic
beryllium
cadmium
chromium
copper
lead
mercury
nickel
selenium
silver
thallium
zinc

MISCELLANEOUS SUBSTANCES

asbestos
cyanide

ORGANIC COMPOUNDS

acenaphthene
acrolein
acrylonitrile
benzene
benzidine
carbon tetrachloride
  (tetrachloromethane)

chlorinated benzenes
  (other than dichlorobenzenes)
    chlorobenzene
    1,2,4-trichlorobenzene
    hexachlorobenzene

chlorinated ethanes
    1,2-dichloroethane
    1,1,1-trichloroethane
    hexachloroethane
    1,1-dichloroethane
    1,1,2-trichloroethane
    1,1,2,2-tetrachloroethane
    chloroethane

chloroalkyl ethers (chloromethyl,
  chloroethyl, and mixed ethers)
    bis (chloromethyl)ether
    bis (2-chloroethyl)ether
    2-chloroethyl vinyl ether (mixed)

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[1] USEPA priority pollutants are toxic constituents and compounds for which technology-based effluent limitations and guidelines are required by Federal law.

Table 2.--U.S. Environmental Protection Agency list of recommended priority pollutants (continued)

ORGANIC COMPOUNDS (continued)

- chlorinated naphthalene
  - 2-chloronaphthalene
- chlorinated phenols (other than those listed elsewhere; includes trichlorophenols and chlorinated cresols)
  - 2,4,6-trichlorophenol
  - para-chloro-beta-cresol
- chloroform (trichloromethane)
- 2-chlorophenol
- dichlorobenzenes
  - 1,2-dichlorobenzene
  - 1,3-dichlorobenzene
  - 1,4-dichlorobenzene
- dichlorobenzidine
  - 3,3'-dichlorobenzidine
- dichloroethylenes
  - 1,1-dichloroethylene
  - 1,2-trans-dichloroethylene
- 2,4-dichlorophenol
- dichloropropane and dichloropropene
  - 1,2-dichloropropane
  - 1,2-dichloropropylene (1,3-dichloropropene)
- 2,4-dimethylphenol
- dinitrotoluene
  - 2,4-dinitrotoluene
  - 2,6-dinitrotoluene
- 1,2-diphenylhydrazine
- ethylbenzene
- fluoranthene
- haloethers (other than those listed elsewhere)
  - 4-chlorophenylphenyl ether
  - 4-bromophenylphenyl ether
  - bis(2-chloroisopropyl) ether
  - bis(2-chloroethoxy)methane
- halomethanes (other than those listed elsewhere)
  - methylene chloride (dichloromethane)
  - methyl chloride (chloromethane)
  - methyl bromide (bromomethane)
  - bromoform (tribromomethane)
  - dichlorobromomethane
  - chlorodibromomethane
- hexachlorobutadiene
- hexachlorocyclopentadiene
- isophorone
- naphthalene
- nitrobenzene
- nitrophenols
  - 2-nitrophenol
  - 4-nitrophenol
  - 2,4-dinitrophenol
  - 4,6-dinitro-o-cresol
- nitrosamines
  - N-nitrosodimethylamine
  - N-nitrosodiphenylamine
  - N-nitrosodi-n-propylamine
- pentachlorophenol
- phenol
- phthalate esters
  - bis(2-ethylhexyl) phthalate
  - butylbenzyl phthalate
  - di-n-butyl phthalate
  - di-n-octyl phthalate
  - dioctyl phthalate
  - dimethyl phthalate
- polynuclear aromatic hydrocarbons
  - benzo(a)anthracene (1,2-benzanthracene)
  - benzo(a)pyrene (3,4-benzopyrene)
  - 3,4-benzofluoranthene
  - benzo(k)fluoranthane (11,12-benzofluoranthene)
  - chrysene
  - acenaphthene
  - anthracene

Table 2.--U.S. Environmental Protection Agency list of recommended priority pollutants (continued)

ORGANIC COMPOUNDS (continued)

- Polynulcear aromatic hydrocarbons (cont.)
  - benzo(ghi)perylene (1,12-benzoperylene)
  - fluorene
  - phenanthrene
  - dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)
  - indeno(1,2,3-cd)pyrene (2,3-o-phenylenepyrene)
  - pyrene

- tetrachloroethylene (tetrachlorethene)
- toluene
- trichloroethylene (trichloroethene)
- vinyl chloride (chloroethene)

- Pesticides and metabolites
  - aldrin
  - dieldrin
  - chlordane (technical mixture and metabolites)

- DDT and metabolites
  - 4,4'-DDT
  - 4,4'-DDE (p,p'-DDE)
  - 4,4'-DDD (p,p'-DDD)

- endosulfan and metabolites
  - α-endosulfan
  - β-endosulfan
  - endosulfan sulfate

- endrin and metabolites
  - endrin
  - endrin aldehyde

- heptachlor and metabolites
  - heptachlor
  - heptachlor epoxide

- hexachlorocyclohexane (all isomers)
  - α-BHC
  - β-BHC
  - γ-BHC (lindane)
  - δ-BHC

- polychlorinated biphenyls (PCBs)
  - PCB-1242 (Arochlor 1242)
  - PCB-1254 (Arochlor 1254)
  - PCB-1221 (Arochlor 1221)
  - PCB-1232 (Arochlor 1232)
  - PCB-1248 (Arochlor 1248)
  - PCB-1260 (Arochlor 1260)
  - PCB-1016 (Arochlor 1016)

- toxaphene

- 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

The geologic logs from these test holes are described in the section titled "Geology" in the discussions of the respective areas; results of the chemical analyses are given in the corresponding "Ground-Water Quality" sections of the site descriptions in the appendices.

Monitoring Wells

Several monitoring wells were installed in the Niagara Falls area to help define the geohydrology of the unconsolidated deposits in that area and the upper part of the Lockport Dolomite. Six additional wells were drilled along the Robert Moses Parkway to monitor the ground-water quality in the unconsolidated deposits along the Niagara River. (Locations are shown in pl. 3.)

Drilling was done by a contract drilling company to specifictions written by the U.S. Geological Survey. The wells, 800 ft apart, were drilled to bedrock or to the top of a relatively impermeable layer, if present. Upon completion, five wells were pumped dry and water levels were allowed to recover; a water sample was then collected for analysis for priority pollutants. One well did not yield sufficient water for a sample.

Another four wells were installed along the gorge of the Niagara River (pl. 3) by contract drillers to obtain information on the quality of ground water that ultimately discharges to the gorge face of the lower Niagara River. Two wells were installed to the Rochester shale, and two in the first permeable zone of the Lockport Dolomite. A sample from each well was analyzed for priority pollutants.

Bedrock Drilling

In the City of Niagara Falls, 11 wells were installed in the Lockport Dolomite (pl. 3) at five sites along the Falls Street Tunnel, an unlined tunnel in the dolomite. Two of the wells were shallow, one placed north and one south of the tunnel, and were screened 5 to 15 ft below the water table to measure the potentiometric surface of ground water in the upper part of the formation. Four deeper wells were installed at three of the sites to measure the potentiometric surface of deeper water-bearing zones. Water samples were collected from nine of the wells and analyzed for the priority pollutants. Well-construction data, geologic logs, and results of chemical analyses are given in the discussion of the Niagara Falls area.

Quality Assurance for Chemical Data

To ensure the validity of chemical data obtained from the study, quality-assurance practices were instituted for sample collection, sample preservation, sample storage and shipping, sample analysis, and data evaluation.

A quality-assurance plan was prepared by the U.S. Geological Survey with assistance of the USEPA to define project organization and responsibility, quality-assurance objectives and practices, corrective actions to be taken in case of discrepancies, and the content and schedules for reports. The plan was written according to the "Interim Guidelines and Specifications for preparing Quality Assurance Project Plans" (USEPA, 1980). The quality-assurance practices are described below; the detection limits and estimated accuracy and precision for each constituent and compound type are given in table 3.

Practices

Sampling and sample preservation.--Drilling equipment was thoroughly washed with water and steam-cleaned before each hole was drilled. After boreholes had been drilled, space around the casing was backfilled with drill cuttings to prevent vertical migration of water. The sequence of drilling was recorded so that contamination of successively drilled wells could be readily detected. Wells were pumped dry three times and water levels allowed to recover before water samples were taken. Pumps and sample bottles were rinsed with hexane and with deionized water free of organic compounds before samples were taken. Except for substrate cores, which were handled with rubber or polyethylene gloves, samples for organic-compound analyses were allowed to touch only glass, Teflon, the untreated side of aluminum foil, silicon-based tubing, or iron.

Table 3.--Detection limits and estimated accuracy and precision for water and substrate samples from Niagara River waste-disposal sites, 1982[1]

Constituent[2]	Sample type	Detection limit	Estimated accuracy (percent recovery)	Estimated precision (relative percent difference)
GC/MS organic compounds, base/neutral extractable	water	1-5 µg/L	40-120	<30
	substrate	300 µg/kg		
GC/MS organic compounds acid-extractable	water	1-5 µg/L	30-100	<30
	substrate	300 µg/kg		
GC/MS organic volatiles	water	1-5 µg/L	70-130	<30
Arsenic, total recoverable	water	1 µg/L	70-130	<30
	substrate	1000 µg/kg		
Cyanide, total recoverable	water	10 µg/L	70-130	<30
	substrate	500 µg/kg		
Fluoride, total recoverable	water	100 µg/L	70-130	<30
Sulfide, total recoverable	water	500 µg/L	70-130	<30
Heavy metals, total	water	1 µg/L		
	substrate	1,000-10,000 µg/kg		
cadmium			63-131	<40
chromium			62-148	<40
copper			52-134	<40
iron			67-141	<40
lead			61-130	<40
mercury			66-130	<40
nickel			73-130	<40
zinc			46-130	<40

[1] Accuracy and precision goals are based on U.S. Environmental Protection Agency laboratory etimates, except for precision of heavy metals, which is based on U.S. Geological Survey Central Laboratory estimates. Goals are based on concentrations of at least 10 times the detection level.

[2] GC/MS = gas chromatograph/mass spectrometer.

Two types of blank water samples were used to detect contamination during sampling or shipping. Trip blanks were bottles of deionized and organic-free water that were mailed from the laboratory to the field, then returned to the laboratory with the samples. Wash blanks were deionized, organic-free water samples that were passed through the iron pipe, tubing, and pumps. The blanks were analyzed by the laboratory for the same organic compounds analyzed in the samples. Duplicates of water and substrate samples were obtained to evaluate the precision of sampling and analysis.

Most blanks and duplicates were obtained during the first few weeks of sampling to validate procedures and to discover sources of contamination occurring during sampling or analysis. The number of quality-control samples was reduced in subsequent weeks to levels commensurate with sample submission.

Unfiltered samples were placed in labeled bottles, treated with preservative, and placed in coolers where they were protected from sunlight, then chilled without being frozen. The amount of sample required, bottle types, preservatives required, and maximum holding times for the constituents in the samples are shown in table 4.

Table 4.--Sampling and analysis procedures for experimental constituents[1]

	Sample type	Minimum amount required	Type of container	Preservative	Maximum holding time	Analytical procedure
GC/MS organic compounds base/neutral- and acid-extractable	water substrate	500 mL 50 g	glass	cool to 4°C	7 days 40 days, extracted	GC/MS[2] do
GC/MS organic volatiles	water	50 mL	glass	cool to 4°C	14 days	GS/MS[3]
Arsenic, total recoverable	water substrate	50-100 mL 10 g	plastic	HNO_3 to pH<2	6 months	Atomic absorption spectrometry, hydride 1979 (p. 73 water, p. 81 substrate)[4]
Cyanide, total recoverable	water substrate	50 mL 10 g	plastic	cool to 4°C NaOH to pH 12	24 hours	Colorimetry (p. 353 water, p. 349 substrate)[4]
Fluoride, total recoverable	water	300 mL	plastic	--	7 days	Ion-selective electrode (p. 529)[4]
Sulfide, total recoverable	water	250 mL	plastic	2 mL Zn-acetate	24 hours	Titrimetry, iodometric (p. 619)[4]
Heavy metals, total recoverable	water substrate	200 mL 10 g	plastic	HNO_3 to pH<2	6 months[5]	Atomic absorption spectrometry (p. 97-277)[4]

[1] U.S. Environmental Protection Agency (1974) and U.S. Geological Survey (1977).
[2] GC/MS, gas chromatograph and mass spectrometer. Variation of method 625 developed by U.S. Geological Survey, (1982, unpublished).
[3] Federal Register, Monday, December 3, 1979, method 624, p. 69532.
[4] Skougstad and others, 1979.
[5] Maximum time for mercury is 13 days.

Storage and shipping.--All samples were stored and shipped in chilled, closed containers. A formal documentation of custody of samples and containers by all personnel (chain-of-custody) was not done.

Sample analysis.--All chemical analyses of soil and water samples collected by the U.S. Geological Survey were analyzed by the Geological Survey Central Laboratory or by USEPA contract laboratories. The USEPA contract laboratories had their own quality control. The quality assurance used by the Geological Survey is discussed below. The complete procedures for calibration and quality control of U.S. Geological Survey laboratory equipment are described in Friedman and Erdmann (1981). Standard operating procedures for each instrument were done according to manufacturer's specifications. Instruments were calibrated daily, and the highest available grade of standards and reagents were used (American Chemical Society grade or equivalent).

Calibration standards for organic compounds were perfluorotributylamine, obtained from the gas-chromatograph and mass-spectrometer manufacturers. Cholesterol, α-terpinol, and nC_{36} were used to check column efficiency and system performance; instrument tuning with decafluorotriphenylphosphine (DFTPP) and bromofluorobenzene (BFB) was done routinely. All organic-compound standards were obtained from the USEPA or the U.S. Food and Drug Administration. Stock solutions were made in the laboratory; highest grade standards available were used.

The following checks were done in the laboratory:

1. At least one replicate analysis was done per two sets of samples (8 samples per set).
2. One spike was added per two sets of water samples.
3. Control charts were used when applicable to determine recovery and repeatability. If the analytical result was not acceptable and the sample was large enough, the analysis was repeated until two or three results agreed; if the sample was insufficient for reanalysis, the result was rejected.
4. One reagent blank was run per set of samples.
5. Internal standards were used as appropriate for the analytical method (Goerlitz and Brown, 1972; Skougstad and others, 1979; and USEPA, 1979).
6. Quality-control samples (USEPA reference samples) were used in place of spiked samples on every 10th spike.
7. Surrogate compounds as specified by the USEPA were added to each water sample, standard, substrate, and blank where organic compound analysis was done.
8. Calibration standards and devices were used as appropriate for method.
9. Reagent checks were performed.

The data-reduction scheme in the laboratory, the principal criteria used to validate data, and the methods used to treat data outliers are described in Friedman and Erdmann (1981), Goerlitz and Brown (1972), and Skougstad and others (1979).

Evaluation of the validity of chemical data.--Data were reviewed according to the project quality-assurance plan and the review process described in USEPA (1982). The following is a summary of the review process:

1. Determine representativeness of the data; that is, verify that the data were the proper type to meet the objectives of the study.

2. Determine completeness of data; that is, whether samples were analyzed for the requested constituents.

3. Identify contaminants in trip blanks, wash blanks, laboratory spike blanks, and glassware blanks. Reject data from samples with concentrations less than or equal to five times the concentration found in the blanks. Data from samples having concentrations greater than 5 times that of the blanks were reduced by subtracting the blank value from the sample value.

4. Estimate accuracy of data from surrogate spike recoveries. The measure of accuracy was percent recovery:

$$\text{Percent recovery} = \frac{\mu\text{g of surrogate found in sample}}{\mu\text{g of surrogate added to sample}} \times 100$$

5. Estimate precision by comparing the results of duplicate samples. Precision was measured by relative percent difference:

$$\text{Relative percent difference} = \frac{S1 - S2}{SM} \times 100$$

where:
S1 = µg of substance in sample 1,
S2 = µg of substance in sample 2,
SM = mean, in µg/L or µg/kg, of the two samples.

6. Determine whether priority pollutants were identified properly by checking a representative number of spectra of compounds reported in the computer quantitation report.

7. Quality-assurance coordinator and analytical coordinator check data and review process.

Results

None of the data were rejected for lack of representativeness. Samples were obtained for a reconnaissance of potential contamination, and all organic compounds present in the samples were identified where their concentration and availability of reference spectra made it possible. Naturally occurring compounds that were identified are listed in table 5.

Except where new samples needed to be obtained, the data were more than 95 percent complete. A few heavy-metal analyses were not performed, either because a sample was too small, the laboratory request sheets were missing or incomplete, or laboratory error occurred.

Organic compounds detected in trip, wash, and laboratory blanks are listed in table 6. Surrogate recoveries for blanks are shown in table 7.

Table 5.--Organic compounds identified as a naturally occurring, possibly naturally occurring, or possible artifact compounds in ground water, surface water, and substrates, 1982.
[Identification by U.S. Geological Survey.]

Naturally occurring organic compounds

Butanoic acid
Benzoic acid
Hexanoic acid
Pentanoic acid
Undecane
1,2-Octanediol
1,3,3-Trimethylbicyclo-[2.2.1] heptan-2-one
1,7,7,-Trimethylbicyclo [2.2.1] heptan-2-one (camphor)
2,2-Dimethyl decane
2-Methylbutanoic acid
5-Butyl-5-nonanol

Possibly naturally occurring organic compounds

Butylcyclooctane
Cyclohexanone
Decane
Dodecane
Eicosane
Heptadecane
Heptanal
Hexadecane
Hexacosane
Nonadecane
Octacosane
Octadecane
Pentadecane
Tetradecane
Tridecane
1-Butoxy-2-propanol
1-Hexanol
2-Hexanone
2-Methylpentadecane
2-Methyl-propanoic acid, butyl ester
2,2-Dimethylundecane
2,3,5-Trimethylundecane
2,6,11-Trimethyldodecane
2,7-Dimethylundecane
3-Hexen-2-one
3-Methylbutanoic acid
3-Methyl-2-pentanone
3,8-Dimethylundecane
4-Methyldecane
4,4,5-Trimethyl-2-hexene
5-Methyl-3-hexen-2-one
5,7-Dimethylundecane
10-Methylisocosane

Possible artifacts

Decamethylcyclopentasiloxane
Dodecamethylcyclohexasiloxane
Octamethylcyclotretrasiloxane
2,6-Dimethyl-2,5-heptadien-4-one (phorone)
4-Hydroxy-4-methyl-2-pentanone
4-Methyl-3-hepten-2-one
4-methyl-3-penten-2-one
5-Methyl-3-hexen-2-one
6-Methyl-3,5-heptadien-2-one

The surrogate recoveries (accuracy) and the precision for the samples are listed in tables 8 through 11. Some samples had surrogate recoveries below quality-assurance goals but were sufficiently close to goals or had a sufficient number of surrogates meeting the goals to justify acceptance of the data. In a few cases, sample extracts evaporated. In others, volatile surro-gates evaporated before being integrated in the sample; therefore, different surrogates were substituted for subsequent analyses. Some substrate samples had zero or minimal surrogate recoveries, but reanalysis showed that the surrogates had sorbed to the substrate matrix. No data were rejected on the basis of surrogate recoveries, but such data are noted in the tables of chemical data. Surrogate recoveries in substrates were found to be related to the time between surrogate addition and extraction. No standard method for surrogate use in substrates is available.

Precision estimates for heavy metals were calculated from duplicate and split samples. In most samples, the precision estimates exceeded quality-assurance goals. Because the types of organic compound analyses used in this study are semiquantitative, precision estimates for the organic compounds under ideal conditions may have deviated by more than ±300 percent and would not have been representative of the sampling precision.

Some sample characteristics often made it impossible to achieve close agreement among organic compound duplicates and may have caused erratic surrogate recoveries. These characteristics are summarized below:

1. Most of the substrate samples contained large stones, chunks of wood, mixed clay, charcoal, or coke that made homogenizing difficult or impossible.

2. Sample concentration was difficult to measure because of heavy, nonvolatile asphaltic residues.

3. The black color of some samples made it impossible to determine when precipitates were forming.

4. Several samples were not concentrated to the intended volume because they became oily and thick.

5. Many components were not well resolved on the packed column for volatile analysis.

6. The oily and nonvolatile components left deposits on the injection liners. Liners had to be changed frequently, and new blanks had to be run.

7. The chromotagrams were extremely complex. Some pesticides could not be quantitated or verified properly.

USEPA officials sent samples containing known quantities of priority pollutants to the U.S. Geological Survey Central Laboratory. Where percent recovery of priority pollutants did not meet quality-assurance goals, the Geological Survey determined the causes of incorrect recovery readings and corrected them. The USEPA considered the Geological Survey's identification and quantification of priority pollutants to be adequate.

Table 6.--Contamination of quality-assurance water blanks, 1982.

[Concentrations in µg/L; LT indicates that contaminants were detected but below the quantifiable detection limit; dashes indicate they were not detected.]

Date collected	Type	Contaminants	Concentration
06-21-82	Trip blank	--	--
06-25-82	do	--	--
06-28-82	do	2,4-Dimethyl-2-pentene[1]	0.4
		Borinic acid, diethyl, methyl ester[1]	4.0
--	Glassware blank for June 1982 laboratory	3,3-Dimethyl-2-butanone[1]	20
		3-Methyl-2-pentanone[1]	62
		2-Methyl-heptane[1]	24
		3-Hexen-2-one[1]	39
		Acetic acid,1-methylester[1]	95
		2,6-Dimethyl heptane[1]	48
		6-(acetyloxy)-2-hexanone[1]	33
		2-Chloronapthalene[1]	90
		Bis(2-ethylhexyl) phthalate[1]	1,100
07-09-82	Trip blank	--	--
07-21-82	Wash blank	1,2-Cyclo hexanediol[1]	5.0
		di-n-butyl phthalate	19
		4-chloro-trans-cyclohexanol	LT
		2,2'-oxybis-propane	LT
		Bis(2-ethylhexyl) phthlate	10
07-21-82	Trip blank	Bis(2-ethylhexyl) phthlate	6.6
		2,2'oxybis-propane[1]	LT
		1,1'-oxybis(3-methyl)butane	LT
07-22-82	do	--[2]	--
07-23-82	do	--[2]	--
07-28-82	Wash blank	--[2]	--
07-28-82	do	--[2]	--
08-02-82	Trip blank	--	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

[2] Sample evaporated.

Table 6.--Contamination of quality-assurance water blanks, 1982 (continued)

[Concentrations in µg/L; LT indicates that contaminants were detected but below the quantifiable detection limit; dashes indicate they were not detected.]

Date collected	Type	Contaminants	Concentration
08-12-82	Trip blank	3-methyl-2-pentenone[1]	23
		Toluene	2.3
		Tetrahydro-5-methyl-trans-2-furanmethanol[1]	3.9
		1,6-Hexanediol[1]	5.0
		2-Cyclohexen-1-ol[1]	13
		2-Cyclohexen-1-one[1]	16
		2-(2-ethoxyethoxy-ethanol[1]	7.1
		1,4-Dichlorobenzene[1]	LT
		4-Chloro-trans-cyclohexanol[1]	17
		Bromophenoxybenzene[1]	1.7
08-18-82	Wash blank	3,3-Dimethyl-2-butanone[1]	14
		2-Methyl-2-pentanol[1]	2.3
		4-Methyl-2-pentanone[1]	1.6
		3-Methyl-2-pentanone[1]	23
		3-Cyclohexen-1-ol[1]	11
		2-Cyclohexen-1-one[1]	15
		2-(2-ethoxyethoxy)ethanol[1]	2.4
		4-Chloro-transcyclohexanol[1]	18
		2,6-Bis(1,1-dimethylethyl)-4-methylmethyl carbamate[1]	1.2
		N-Phenylbenzenamine[1]	2.5
		4-(1,1,3,3-Tetramethylbutyl)-phenol[1]	1.0
		Di-n-butyl phthalate	1.1
08-20-82	Trip blank	Methoxycyclohexane	10
	Spike	Bis(2-ethylhexyl) phthalate	90
	Glassware blank	--	--
	Glassware blank	--	--
	Glassware blank	2-Cyclohexen-1-ol	LT
		2-Cyclohexen-1-one	LT
		1,2-Cyclohexanediol	LT
	Spike	2,3-Dichlorophenol[1]	4.3
		1,2-Dihydroacenaphthylene[1]	14
		2-Methyl-1-1-biphenyl[1]	10

Table 7.--Surrogate recoveries from water blanks

(All values are in percent; dashes indicate analysis not performed.)

Date collected	Sample type	Surrogate				
		(1) Decafluoro-biphenyl (2) 1-fluoro-napthalene	2,2-Difluoro-biphenyl	Phenol-d6	Trifluoro-m-cresol	(1) Tribromophenol (2) Dibromophenol (3) Dibromobenzene
	Water spike	-	47	75	-	(1)140,(2)105,(3)60
	Quality control sample 2	(2) 61	66	-	-	-
	Quality control sample 3 (acid only)	-	-	64	25	-
	Water spike	-	44	19	-	-
06-21-82	Trip blank	-	-	51	76	-
	Water spike	-	-	61	66	
	Water spike	-	-	40	40	-
	Water spike	-	-	45	67	-
	Water spike	(2) 29	95	31	66	-
	Water spike	(2) 71	28	90	-	(2)20,(3)70
	Glassware blank	(2) 27	22	60	-	(1)44,(2)28,(3)27
06-25-82	Trip blank	-	-	76	90	-
06-28-82	Trip blank	(2) 52	82	12	30	-
07-09-82	Trip blank	(2) 79	84	40	69	-
07-21-82	Wash blank	(2) 71	74	40	68	-
07-21-82	Trip blank	(2) 75	84	45	73	-
07-22-82	Trip blank	-	-	60	67	(3) 58
07-23-82	Trip blank	-	-	48	100	(3) 47
07-23-82	Trip blank	-	-	97	100	(3) 98
07-28-82	Wash blank					
07-28-82	Wash blank					
	Water spike	-	73	75	-	(1)80,(2)70,(3)69
08-02-82	Trip blank					
08-12-82	Trip blank	-	57	56	-	(1)67,(2)58,(3)56
	Water spike	-	61	70	-	(1)86,(2)89,(3)83
08-18-82	Wash blank	-	55	41	-	(1)51,(2)47,(3)48
08-20-82	Trip blank	-	69	64	-	(1)71,(2)86,(3)73
08-20-82	Wash blank	-	55	41	-	(1)51,(2)47,(3)48
09-08-82	Trip blank		38	46	-	(1)26,(2)30
09-08-82	Trip blank	(2)64	73	46	-	(2)64,(3)51
	Water spike	(2)42	54	51	-	(1)48,(2)75,(3)40
-	Water spike	-	47	75	-	(1)140,(2)105,(3)60

Table 8. Quality-assurance results for waste-disposal sites

[Site locations shown in specific site descriptions.]

				Surrogate Recoveries (in percent)					Precision
Date collected	Site name and number	Sample no.	Sample type	(1) Decafluoro-biphenyl (2) 1-Fluoro-napthalene	2,2-Difluoro-biphenyl	Phenol-d6	Trifluoro-m-cresol	(1) Tribromophenol (2) Dibromophenol (3) Dibromobenzene	(Relative Percent Difference)
06-18-82	Botanical Gardens	1	water^2	(2)68	78	-	-	-	-
do	(243) do	1	do ^{2}	-	87	-	-	-	-
do	do	2	do	(1)28	58	102	99	-	-
06-19-82	Lynch Park (076)	1	substrate						
do	do	2	do	(2)74	70	41	62	-	-
do	do	3	do						
06-21-82	Holiday Park (072)	1	water	(1)31	35	55	64	-	-
do	do	2	do	(1)65	56	101	99	-	-
06-19-82	do	3	do	-	35	77	70	-	10,10
do	do	3	do	(1)63	65	68	73	-	do
do	do	4	do	(1)31	35	82	63	-	-
06-21-82	do	5	do	(1)42	34	60	54	-	15,0
do	do	5	do	(1)85	65	138	59	-	do
do	do	6	do	(1)60(63)	62(93)^1	86(37)^1	124(12)^1	-	-
06-17-82	do	7							
do	do	8	substrate	(2)67	43	87	-	(1)5,(2)16,(3)72	0,4
do	do	8	do	(2)96	86	200	-	(1)59,(2)77,(3)87	do
06-21-82	do	9	water	(1)34(36)	36(59)^1	65	80	-	-
06-21-82	Buffalo Pumps (083)	1	water	-	-	-	-	-	-
do	do	2	do	-	-	-	-	-	-
06-22-82	NCRD,Wheatfield (081)	1	substrate	(2)64(64)	36(42)^1	73(92)^1	-	(1)4(5)^1,(2)10(13)^1 (3)59(66)^1	-
do	do	2	do	(2)12	10	5	2	-	-
do	do	3	do						
06-23-82	do	4	do	(2)85	69	70	40	-	-
	do	5							
	do	6	water	(2)31	58	16	48	-	-
06-25-82	do	7	do	(2)54	40	-	-	-	-
do	do	7	do	(2)48	51	-	-	-	-
07-09-82	do	7	substrate	(2)81	72	24	-	(2)25	-
do	do	8	do^3	(2) 0^1	0^1	0^1	-	(1)0^1	-
do	do	9	do^3	(2)42(103)^1	43(95)^1	29(74)^1	-	(1)0(66)^1,(2)0(51)^1	-
do	do	10	do^3	(2)66^1	41^1	22^1	-	(1)0^1,(2)0^1	-
do	do	11	do^3	(2)15^1	14^1	9^1	-	(1)0^1,(2)0^1	-

Table 8. Quality assurance results for waste-disposal sites (continued)

				Surrogate Recoveries (in percent)					Precision
Date collected	Site name and number	Sample no.	Sample type	(1) Decafluoro-biphenyl (2) 1-Fluoro-napthalene	2,2-Difluoro-biphenyl	Phenol-d6	Trifluoro-m-cresol	(1) Tribromophenol (2) Dibromophenol (3) Dibromobenzene	(Relative Percent Difference)
06-24-82	Nash Road (093)	1	water^4	(2) 85	53	-	-	-	0 to 25
do	do	1	do ^{4}	(2) 2	45	-	-	-	do
do	do	2	substrate	(2)113	83	68	50	-	0 to 50
do	do	2	do	(2) 19	81	31	73	-	do
do	do	3	do	(2) 84	57	23	24	-	-
do	do	4	do	-	106	40		(1)131,(2)88,(3)59	-
06-22-82	Frontier Chemical	1	water	-	-	-	-	-	-
06-25-82	do (067)	2	do	-	-	-	-	-	0 to 26
do	do	2	do	-	-	-	-	-	do
do	do	3	substrate	-	-	-	-	-	-
	do	4	water	-	-	-	-	-	-
06-26-82	Niagara River	1	water	(2) 31	56	13	87	-	-
do	do (094)	2	do	(2)133	129	27	133	-	-
06-28-82	Gratwick Park	1	water^4	-	6	11	22	-	-
do	do (068)	2	do ^{3}	-	-	-	-	-	-
do	do	3	do	(2) 59	65	12	25	-	-
do	do	4	do ^{3}	(2) 57	69	20	100	-	-
do	do	5	do	(2)122	148	25	130	-	-
06-28-82	Great Lakes Carbon	1	substrate	(2) 62	56	91	-	(1),8,(2)27,(3)62	-
do	do (022)	2	do	(2) 59	37	71		(2)10,(3)62	-
do	do	3	water	(2) 70	124	61	123	-	-
do	do	4	do	(2) 19	28	19	49	-	-
06-28-82	Art Park (063)	1							
do	do	2							
do	do	3	water	(2) 76	89	22	46	-	-
08-21-82	do	4	substrate^3	(2) 0^1	3^1	0^1	0^1	(1)0^1,(2)0^1	-
do	do	5	do	(2) 70	55	35	-	(1)47,(2)39	-
do	do	6	do^3	(2) 20^1	11^1	2^1	-	(1)9^1,(2)71^1	-
06-28-82	Whirlpool (089)	1	substrate						-
		2	do	-	92	76	-	(1)30,(2)98,(3)75	-
06-25-82	Buffalo Ave. (083)	1	substrate	(2) 70	130	7	8	-	0 to 9
	do	1	do	(2) 17	24	4	9	-	do
	do	3							-
	do	4							-
	do	5							-
	do	6							-

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[1] Analysis repeated

[2] Niagara County Refuse Disposal

[3] Matrix interferences

[4] Acid portion evaporated

Table 8. Quality assurance results for waste-disposal sites (continued)

[Site locations shown in specific site descriptions.]

Date collected	Site name and number	Sample no.	Sample type	Surrogate Recoveries (in percent): (1) Decafluoro-biphenyl (2) 1-Fluoro-napthalene	2,2-Difluoro-biphenyl	Phenol-d6	Trifluoro-m-cresol	(1) Tribromophenol (2) Dibromophenol (3) Dibromobenzene	Precision (Relative Percent Difference)
06-28-82	Buffalo Ave.	7							-
do	do (083)	8							-
do	do	9							-
do	do	10							-
do	do	11							-
06-30-82	do	12	substrate	(2) 63	53	90	-	(2)15,(3)70	-
do	do	13	do	(2) 65	51	91	-	(1)9,(2)21,(3)61	-
07-02-82	64th St. N. (088)	1	substrate	(2) 9	5	28	-	(1)4,(2)2	-
do	do	2	do	(2) 64	68	27	-	(1)70,(2)63,(3)56	-
	City of	1							-
07-10-82	Tonawanda Dump	2	water	(2) 20	75	50	82	(1)62	-
	do (207)	3							
	do	4							
08-21-82	do	5	substrate^{3}	(2) 9^{1}	10^{1}	0^{1}	-	(1)0^{1},(2)0^{1}	-
do	do	6	do^{3}	(2) 13	8	2	-	(1)12,(2)4	-
do	do	7	do	(2) 85	65	47	-	(1)52,(2)51	-
do	do	8	do	(2) 66	46	25	-	(1)44,(2)34	-
08-27-82	do	9	do^{3}	(2) 32	15	4	-	(1)0,(2)0,(3)31	-
do	do	10	do^{3}	(2) 0^{1}	0^{1}	0^{1}	-	(1)0^{1},(2)0^{1}	-
07-29-82	J.H. Williams Co.	1							-
	do (160)	2							-
	do	3							-
	do	4	substrate	-	47	57	-	(1)140,(2)105,(3)60	-
07-29-82	Squaw Island	1							-
do	do (203)	2							-
do	do	3	substrate	(2) 56	80	104	-	(1)76,(2)78,(3)59	-
do	do	4	do	(2)100	19	86	-	(1)94,(2)92,(3)94	-
08-30-82	do	5							
do	do	6	do^{3}	(2) 40	38	4	-	(1)10,(2)4	
do	do	7	do^{3}	(2) 16	11	0	-	-	
do	do	8	do^{3}	(2) 40	38	27	-	(1)40,(2)30,(3)26	
do	do	9	do^{3}	(2) 15	17	1	-	-	
07-30-82	Lucidol Division (137)	1	substrate	-	60(72)^{1}	60(76)^{1}	-	(1)45(48)^{1},(2)62(72)^{1}, (3)60(69)^{1}	-
do	do	2	do	-	62	28	-	(1)110,(2)56,(3)70	-
do	do	3	do	-	55	42	-	(1)37,(2)57,(3)48	-
do	do	4	do	-	57	47	-	(1)85,(2)61,(3)54	-
08-04-82	Wm. Stausman Prop	1	substrate	(2) 68	76	50	-	(1)53,(2)50,(3)73	-
do	do (204)	2	do	(2) 42	30	17	-	(1)21,(2)18,(3)47	-
do	do	3	do	(2) 54	61	41	-	(1)39,(2)34,(3)55	-
do	do	4	do	(2) 74	81	64	-	(1)52,(2)61,(3)79	-

Table 8. Quality assurance results for waste-disposal sites (continued)

Date collected	Site name and number	Sample no.	Sample type	Surrogate Recoveries (in percent)					Precision
				(1) Decafluoro-biphenyl (2) 1-Fluoro-napthalene	2,2-Difluoro-biphenyl	Phenol-d6	Trifluoro-m-cresol	(1) Tribromophenol (2) Dibromophenol (3) Dibromobenzene	(Relative Percent Difference)
08-05-82	Donner Hanna Coke	1	substrate	(2) 73	49	46	-	(2)24,(3)75	-
do	do (217)	2	do	(2) 57	14	-	-	(3)69	-
do	do	3	do	(2) 62	-	-	-	(3)77	-
do	do	4	do	(2) 71	30	-	-	(3)49	-
08-05-82	McNaughton Brooks	1	substrate	(2) 56	55	42	-	(1)41,(2)40,(3)56	-
do	do (138)	2	do	(2) 48	50	62	-	(1)36,(2)47,(3)42	-
do	do	3	do	(2) 66	37	-	-	(1)8,(3)83	-
do	do	4	do	(2) 73	55	21	-	(1)11,(2)21,(3)61	-
08-11-82	R. P. Adams (103)	1	substrate	(2) 58	38	31	-	(1)32,(2)30	-
do	do	2	do	(2) 69	52	25	-	(1)86,(2)39	-
do	do	3	do	(2)150	50	37	-	(1)34,(2)33	-
do	do	4	do	(2)110	89	63	-	(1)78,(2)63	-
08-12-82	Stauffer Chemical	1							
do	do (300)	2	substrate	(2) 58(7)^1	15(1)^1	0(1)^1	-	(1)11(0)^1,(2)10(0)^1	-
do	do	3	do	(2) 47	40	39	-	(1)0,(2)27,(3)38	-
do	do	4	do	(2) 51	52	42	-	(1)41,(2)39,(3)56	-
08-18-82	Dupont of	1	substrate	-	49	103	-	(1)1,(2)8,(3)154	-
do	Tonawanda (128)	2	do	-					
do	do	3	water	-	55	32	-	(1)51,(2)47,(3)48	-
do	do	3	do	-	62	48	-	(1)60,(2)55,(3)58	-
do	do	3	do	-	31	29	-	(1)77,(2)52,(3)48	-
do	do	4	water	-	35	27	-	(1)37,(2)54,(3)54	-
do	do	5							
do	do	6	do	-	42	35	-	(1)57,(2)82,(3)66	-
do	do	7	do	-	12	93	-	(1)124,(2)11,(3)31	-
08-19-82	Modern Disposal	1	do	-	29	33	-	(1)54,(2)80,(3)38	-
do	do (077)	2	do	-	34	35	-	(1)73,(2)84,(3)47	-
08-20-82	Quinns Motel ( )	1	substrate	(2) 15	11	8	-	(1)0,(2)0	-

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[1] Analysis repeated
[2] Niagara County Refuse Disposal
[3] Matrix interferences
[4] Acid portion evaporated

Table 8. Quality assurance results for waste-disposal sites (continued)

[Site locations shown in specific site descriptions.]

Date collected	Site name and number	Sample no.	Sample type	Surrogate Recoveries (in percent)					Precision
				(1) Decafluorobiphenyl (2) 1-Fluoronapthalene	2,2-Difluorobiphenyl	Phenol-d6	Trifluoro-m-cresol	(1) Tribromophenol (2) Dibromophenol (3) Dibromobenzene	(Relative Percent Difference)
08-20-82	Union Carbide	1	water	-	32	30	-	(1)57,(2)80,(3)42	-
do	do (064)	2	do	-	31	32	-	(1)33,(2)81,(3)45	-
08-26-82	West Seneca Transfer Station	1	substrate[3]	-	-	-		(1)18,(2)0	-
do	do (220)	2	do[3]	(2) 14	5	1	-	(1)0,(2)0	-
do	do	3	do[3]	(2) 19(115)[1]	20(111)[2]	18(83)[1]	-	(1)8(80)[1],(2)16(61)[1]	-
do	do	3	do[3]	(2) 62	32	13		(1)0,(2)17,(3)63	-
do	do	4	do[3]	(2) 38	25	6		(1)0,(2)0,(3)33	-
08-27-82	97th St. Church	1	substrate[3]	(2) 0	1	0	-	(1)0,(2)0,(3)0	-
do	do (245)	2	do[3]	(2)111[1]	9[1]	6[1]	-	(1)8[1],(2)6[1],(3)10[1]	-
do	do	3	do[3]	(2) 9	7	3	-	(1)0,(2)0	-
do	do	4	do[3]	(2) 0	07	63	-	(1)99,(2)108,(3)111	-
do	do	4	do[3]	(2) 25	0	6	-	(1)0,(2)108,(3)24	-
08-30-82	Otis Elevator(144)	1	substrate	(2) 16	11	9	-	(1)0,(2)7	-
09-08-82	Creekside Golf Course (252)	1	water	(2) 55	57	41	-	(1)105,(2)50,(3)45	-
08-25-82	do	1	substrate[3]	(2) 4	2	-	-	-	
do	do	2	do[3]	(2) 4	3	-	-	-	
do	do	3	do[3]	(2) 44	29	20	-	(1)16,(2)126	-
09-08-82	do	3	water	(2) 63	72	55	-	(1)114,(2)69,(3)55	
See quality assurance results for unconsolidated deposits in Niagara Falls, bedrock wells in Niagara Falls, and wells along Niagara River - Robert Moses Parkway									
01-01-82	Cayuga Island(084)	1	water	(2)75	100	81	-	(1)115,(2)111,(3)86	-
01-04-82	Hydraulic Canal (086)	1	water	(2)52	63	59	-	(1)92,(2)67,(3)70	-

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[1] Analysis repeated
[2] Niagara County Refuse Disposal
[3] Matrix interferences
[4] Acid portion evaporated

Table 9.--Surrogate recoveries for ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982 through January 1983.

[All values are in percent; locations shown in pl. 3.]

Site	(1) Bromochloromethane (2) 1-Bromo-2-chloroethane	(1) d6 Benzene (2) Flourobenzene
American Falls Park, 109 ft well	(1)85, (2)97	(1)102, (2)102
do 47 ft well	(1)61, (2)62	(1)70, (2)71
Robert Moses Parkway, well no. 1	(1)88, (2)79	(1)85, (2)87
do well no. 2	(1)94, (2)94	(1)105, (2)107
13th Street	(1)93, (2)74	(1)66, (2)70
14th Street	(1)92, (2)72	(1)56, (2)67
Cudaback Street	(1)86, (2)66	(1)58, (2)62
Niagara Street	(1)67, (2)64	(1)71, (2)73
61st Street	(1)66, (2)56	(1)60, (2)65
60th Street	(1)64, (2)60	(1)63, (2)66
Power Authority State of NY well no. 1	(1)69, (2)105	(1)96, (2)95
do well no. 2	(1)112, (2)109	(1)93, (2)103
do well no. 3	(1)101, (2)105	(1)101, (2)115

	(1) 1-Fluoronapthalene (2) p-Dibromobenzene (3) 2,2'-Difluorobiphenyl	(1) Phenol-d6 (2) Dibromophenol (3) 2,4,6-Tribromophenol
American Falls Park, 109 ft well	(1)55, (2)59, (3)64	(1)65, (2)70, (3)103
do 47 ft well	(1)64, (2)74, (3)85	(1)43, (2)46, (3)88
Robert Moses Parkway, well no. 1	(1)48, (2)46, (3)76	(1)65, (2)65, (3)94
do well no. 2	(2)34, (3)55	(1)64, (2)55, (3)97
13th Street	(1)94, (2)105, (3)79	(1)62, (2)43
14th Street	(1)44, (2)50, (3)50	(1)47, (2)35, (3)58
Cudaback Street	(1)77, (2)99, (3)70	(1)52, (2)40, (3)56
Niagara Street	(1)53, (2)66, (3)60	(1)36, (2)38, (3)50
61st Street	(1)91, (2)89, (3)96	(1)57, (2)53, (3)57
60th Street	(1)61, (2)78, (3)60	(1)43, (2)35, (3)56
Power Authority State of NY no. 1	(1)46, (2)57, (3)44	(1)42, (2)66, (3)94
do no. 2	(1)60, (2)71, (3)61	(1)45, (2)70, (3)106
do no. 3	(1)52, (2)63, (3)44	(1)44, (2)76, (3)97

Table 10.--Surrogate recoveries for ground-water samples from wells in the unconsolidated deposits along the Niagara River, Robert Moses Parkway, N.Y., January 1983.

[All values are in percent; locations are shown in pl. 3.]

Site	(1) Bromochloromethane (2) 1-Bromo-2-chloroethane	(1) d6 Benzene (2) Flourobenzene
Robert Moses Parkway no. 2	(1)54, (2)124	(1)101, (2)103
do no. 3	(1)124, (2)104	(1)99, (2)98
do no. 4	(1)39, (2)123	(1)105, (2)101
do no. 5	(1)95, (2)102	(1)83, (2)93
do no. 6	(1)105, (2)119	(1)117, (2)92

Site	(1) 1-Fluoronapthalene (2) p-Dibromobenzene (3) 2,2'-Difluorobiphenyl	(1) Phenol-d6 (2) Dibromophenol (3) 2,4,6-Tribromophenol
Robert Moses Parkway no. 2	(1)41, (2)51, (3)45	(1)37, (2)61, (3)76
do no. 3	(1)76, (2)45, (3)48	(1)1, (2)34, (3)27
do no. 4	(1)71, (2)90, (3)77	(1)73, (2)122, (3)165
do no. 5	(1)61, (2)71, (3)59	(1)78, (2)82, (3)109
do no. 6	(1)50, (2)61, (3)52	(1)52, (2)75, (3)63

Table 11.--Surrogate recoveries for ground-water samples from wells used to characterize area water quality; Buffalo, Tonawanda, and Niagara Falls, N.Y., November 1982.

[All values in percent; locations shown in pls. 2 and 3.]

Site	(1) Bromochloromethane (2) 1-Bromo-2-chloroethane	(1) d6 Benzene (2) Flourobenzene
Department of Transportation	(1)109, (2)113	(1)116, (2)124
Shawnee Road	(1)73, (2)124	(1)115, (2)119
Niagara Falls Boulevard	(1)97, (2)132	(1)121, (2)114
Whitmer Road	(1)91, (2)104	(1)97, (2)92
Airport Triangle	(1)100, (2)143	(1)112, (2)100
I90-R62 Interchange	(1)115, (2)94	(1)113, (2)114
West Seneca Street	(1)116, (2)98	(1)95, (2)127
Griffon Park	(1)110, (2)115	(1)120, (2)125
Gratwick Park	(1)101 (116)[1], (2)100 (112)[1]	(1)99 (103)[1], (2)104 (129)[1]

Site	(1) 1-Fluoronapthalene (2) p-Dibromobenzene (3) 2,2'-Difluorobiphenyl	(1) Phenol-d6 (2) Dibromophenol (3) 2,4,6-Tribromophenol
Department of Transportation	(1)32, (2)32, (3)36	(1)36, (2)69, (3)36
Shawnee Road	(1)32, (2)38, (3)43	(1)52, (2)128,(3)83
Niagara Falls Boulevard	(1)42, (2)47, (3)47	(1)36, (2)108,(3)88
Whitmer Road	(1)35, (2)34, (3)31	(1)33, (2)134,(3)47
Airport Triangle	(1)49, (2)41, (3)29	(1)47, (2)79, (3)32
I90-R62 Interchange	(1)37, (2)40, (3)35	(1)39, (2)83, (3)30
Seneca Street	(1)62, (2)64, (3)58	(1)49, (2)85, (3)29
Griffon Park	(1)57, (2)88, (3)65	(1)56, (2)95, (3)25
Gratwick Park	(1)62, (2)86, (3)67	(1)44, (2)105,(3)43

[1] Analysis repeated

EVALUATION OF CONTAMINANT MIGRATION

This report evaluates the potential for ground-water contamination from migration of hazardous wastes in a qualitative manner only; a quantitative assessment would require efforts beyond the scope of this preliminary survey. The following paragraphs give (1) criteria for the qualitative assessment of contaminant-migration potential, (2) a general method for computing the rate and quantity of chemical discharges, should sufficient data become available, and (3) suggestions for future quantitative studies to assess the regional effects of contaminant migration on the Niagara River.

Qualitative Assessment

All sites are designated as having either a major or indeterminable potential for contaminant migration in ground water, as described below:

Major potential.--These sites are close to the river or a tributary and (1) contain hazardous constituents or chemicals and have permeable soils or sufficient ground-water gradients for ground-water movement, as evidenced by site records, chemical analyses, and water-level or core analyses; and(or) (2) have evidence that offsite migration of hazardous contaminants has already occurred.

Indeterminable.--These sites were those for which data were inadequate to make a realistic assessment of contaminant migration; that is, where either the geohydrologic data or the chemical data were insufficient to indicate the potential for offsite migration.

Of the 138 sites evaluated in this study, 61 were judged to have a major potential for contaminant migration and are listed in table 12. The sites having a major potential may already be contaminating the river(s). The sites designated as having indeterminable potential may be reclassified as other data become available.

Quantitative Assessment

A quantitative assessment of migration rates and amount of contamination was beyond the scope of this study; however, a general procedure for calculating chemical discharges to the river, based on representative data from this study as an example, is given below. The methods presented herein should be used with extreme caution. The values would be, at best, an indication of relative differences between sites.

General Considerations

At some sites, the ground-water or substrate samples may have been obtained from within the disposal area and therefore could not be used to determine offsite migration. Many of the soil samples were taken from above a clay or confining unit that was unsaturated; chemical migration in such layers would be considerably slower than in saturated units.

Table 12.--Sites designated as having a major potential for contaminant migration to ground water.

[Locations are shown in pls. 1-3.]

Site no.	Site name	EPA number
	BUFFALO AREA (10 sites)	
107	Allied Chemical	915004
118	Bethlehem Steel Company	915009
120-122	Buffalo Color Corp.	915012a-c
138	McNaughton-Brooks, Inc.	915034
141	Mobil Oil Corporation	915040
162	Alltift	915054
203	Squaw Island	915052
241	Times Beach	915080
	TONAWANDA AREA (20 sites)	
24-37	Occidental, Durez	932018
68	Gratwick-Riverside Park	932060
105	Allied Chemical	915003-b
108	Tonawanda Coke	915055-a
123	Columbus McKinnon Corporation	915016
136	INS Equipment Corporation	915031
182	Huntley Power Station	915063
	NIAGARA FALLS AREA (31 sites)	
5	Bell Aerospace	932052
14	DuPont, Necco Park	932047
15-19,250	DuPont, Buffalo Avenue	932013a-f
38	Occidental, Love Canal	932020
39	Occidental, Hyde Park	932021
40	Occidental, 102nd Street	932022
41	Occidental, Buffalo Avenue S-Area	932019a
41a-49	Occidental, Buffalo Avenue Plant	932019b-i
56	Olin, 102nd Street	932031
58,59,248	Olin, Buffalo Avenue Pland	932051a,b, and 932038
66	Reichold-Varcum	932040
81	Niagara County Refuse Disposal	932026
83	Buffalo Avenue	932080
85	Griffon Park	932081
242	Charles Gibson	932096
251	Solvent Chemical	--

To assess the effects of each site on the Niagara River would require evaluation of geohydrologic and plume characteristics of each site by periodic, long-term monitoring. Specific knowledge of the following would be required:

1. Type and extent of unconsolidated material and bedrock units.
2. Vertical and horizontal permeability for pertinent geologic units. (Horizontal and vertical permeabilities are not equal.)
3. Rate and direction of ground-water flow (based on potentiometric gradients and saturated thickness of units.)
4. Effect of manmade disturbances such as conduits, storm drains, sanitary sewers, water lines, retaining walls, etc., on rate or direction of flow.
5. Sources, extent, and characteristics of chemical plumes, including contaminant concentrations and time and spatial variation.
6. Contaminants' degree of mixing and rate of leaching.
7. Chemical interactions, changes, and attenuation between site and river.

Method of Computation

An analytical approach for calculating discharges to the river would use Darcy's law, expressed by the following equation:

$$v = \frac{ki}{n} \tag{1}$$

where: v = average linear velocity of ground-water movement
k = permeability of the material
i = hydraulic gradient
n = the effective porosity of the material

The equation can be used if the values are known and have small variability. A two-dimensional sketch showing these relationships in a ground-water system is given in figure 2. Some estimated values for these variables in the Erie-Niagara County area are given below.

Permeability.--Permeability tests on the porous fill and sand from some sites yielded mean values of about 10^{-3} cm/s. The vertical permeability of the clay units at the sites ranged from 10^{-6} to 10^{-9} cm/s; no data on horizontal permeabilities are available. Clay is highly anisotropic owing to the internal structure and alignment of the platey minerals that form it; therefore, horizontal permeability within clay can exceed the vertical permeability a hundredfold Sand stringers in clay may increase both horizontal and vertical permeability of a given unit.

Hydraulic gradient.--The hydraulic gradients in the areas studied are poorly defined. During the test-drilling phase of the study in 1982, perched water was encountered above a clay unit at many sites, and the regional water table was encountered within the clay. The differences in hydraulic head between the perched water and the water table varied considerably among sites--generally from 0.5 to 5 ft, although greater differences occurred at some sites.

The vertical hydraulic gradient is calculated by dividing the difference between water levels at two wells in the same unit by the saturated thickness of the unit (fig. 2). Horizontal hydraulic gradients is calculated by dividing the difference between water-level altitude in two wells by the distance (L) between the wells (fig. 2). In general, the horizontal gradients at the sites studied are relatively small except in areas where geologic conditions or artificial recharge have caused ground-water mounding.

Effective porosity.--The effective porosity (the fraction of interconnected pore space available for fluid transmission) of the materials at the sites studied is estimated to range from 0.3 to 0.7. Fill and sand porosity ranges from 0.3 to 0.4, and clay porosity ranges from 0.5 to 0.7.

Flow velocity.--Substituting the maximum and minimum values for the variables discussed above into equation 1 yields the ranges of horizontal and vertical velocity of ground water given below:

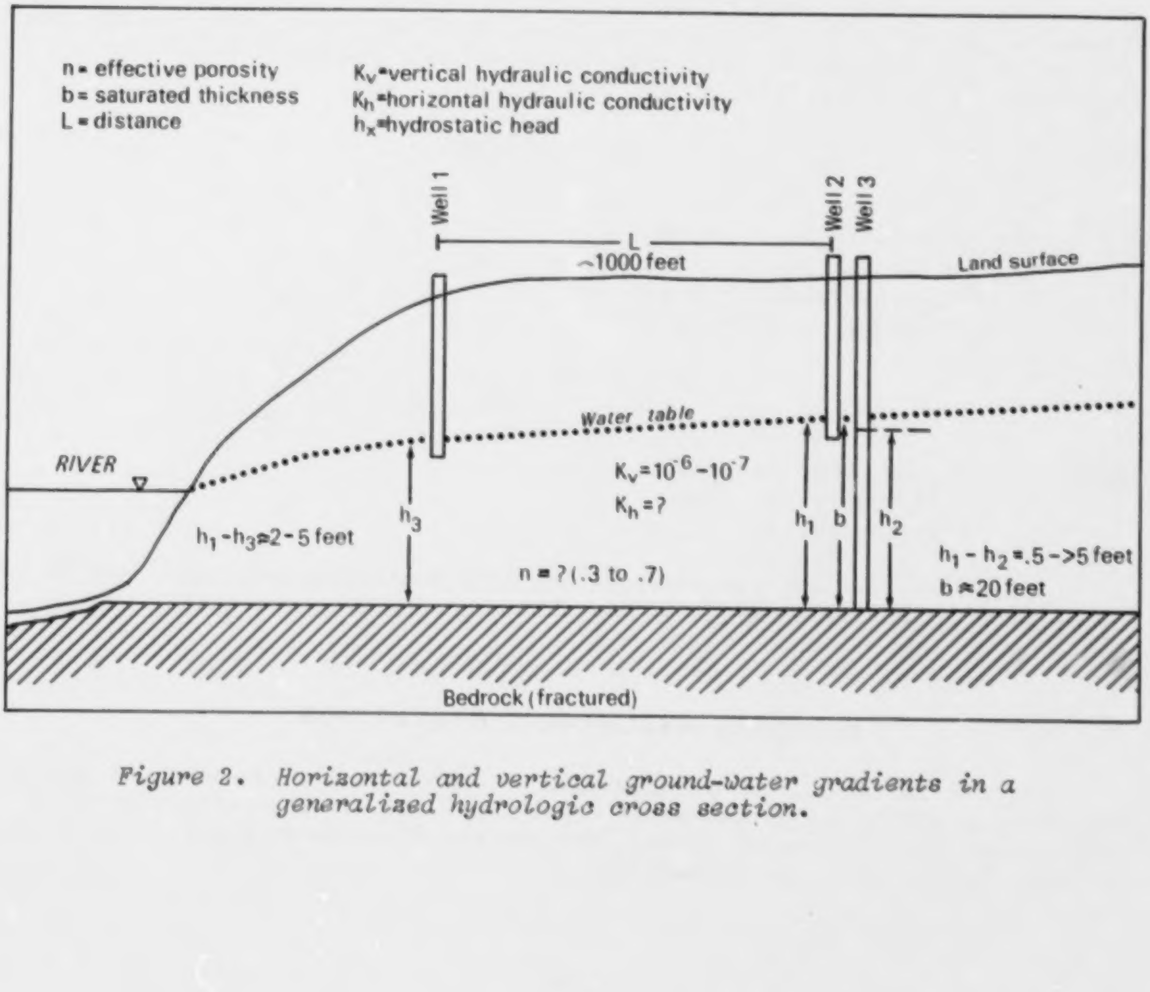


Figure 2. Horizontal and vertical ground-water gradients in a generalized hydrologic cross section.

Vertical velocity:

$$V\text{max} = \frac{ki}{n} = \frac{(2.8 \times 10^{-3}\ \text{ft/d})\ \left(\frac{5}{20}\ \text{ft}\right)}{0.3} = 2.4 \times 10^{-3}\ \text{ft/d}$$

$$V\text{min} = \frac{ki}{n} = \frac{(2.8 \times 10^{-6}\ \text{ft/d})\ \left(\frac{5}{20}\ \text{ft}\right)}{0.7} = 1 \times 10^{-6}\ \text{ft/d.}$$

Horizontal velocity:

$$V\text{max} = \frac{(2.8 \times 10^{-1}\ \text{ft/d})\ (.005\ \text{ft})}{0.3} = 0.005\ \text{ft/d}$$

$$V\text{min} = \frac{(2.8 \times 10^{-3}\ \text{ft/d})\ (.002\ \text{ft})}{0.7} = 8 \times 10^{-6}\ \text{ft/d.}$$

The calculations indicate that ground-water movement in the area studied is relatively slow and ranges over three orders of magnitude. The application of such a wide range may be inappropriate for specific site analysis; local geologic and hydrologic variations could change the velocities substantially.

Contaminant flux.--To assess the rate of contaminant discharge to the river from equation (1), multiply the velocity by the cross-sectional area of a site and by the effective porosity, then by appropriate conversion factors to obtain discharge, in gal/d (eq. 2). Then multiply the flow rate by the chemical concentration and appropriate conversion factors to obtain the flux of contaminants, in lb/d (eq. 3).

$$Q = vAn \times \frac{7.48\ \text{gal}}{\text{ft}^3} \qquad (2)$$

where:
Q = flow rate, in gal/d;
v = average linear velocity, in ft/d;
A = cross-sectional area, in ft^2;
n = effective porosity.

$$F = QC \times 3.785\ \frac{\text{L}}{\text{gal}} \times \frac{\text{lb}}{4.54 \times 10^{8}\ \mu\text{g}} \qquad (3)$$

where:
F = flux of contaminants, in lb/d;
Q = flow rate, in gal/d;
C = concentration, in μg/L.

Again, note that the calculations are only an example and should not be used as measures of contamination from the sites.

REGIONAL HYDROLOGIC EVALUATION

This section describes hydrogeologic character--the unconsolidated deposits and bedrock units, the ground-water conditions, and the general ground-water quality--of the three study areas. The individual waste-disposal sites in each area are described in the appendices.

BUFFALO AREA

Geology

The Buffalo study area (pl. 1) consists of units of sedimentary bedrock composed of shale, limestone, and dolomite overlain by unconsolidated deposits of clay, sand, and till. The bedrock units are of Silurian and Devonian age; the unconsolidated deposits are primarily of Pleistocene age. The extent of the sedimentary bedrock units is shown in figure 3; the distribution of the unconsolidated units is shown in figure 4.

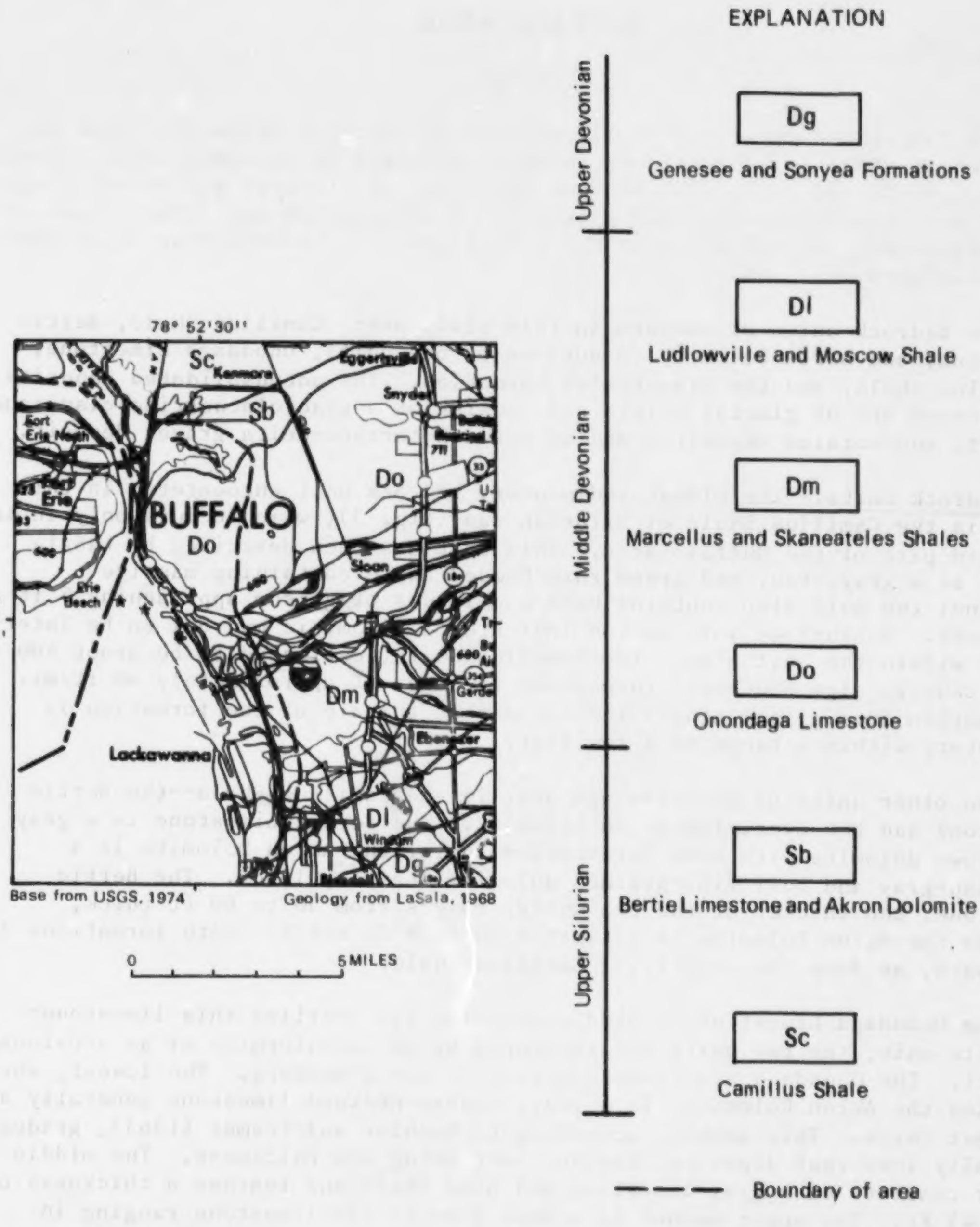
The bedrock units of concern in this study are: Camillus Shale, Bertie Limestone, and Akron Dolomite (described as one unit); Onondaga Limestone; Marcellus Shale, and the Skaneateles Formation. The unconsolidated deposits of interest are of glacial origin and consist of a glaciolacustrine clay-sand deposit, end-moraine deposits, and an outwash-terrace-delta gravel deposit.

Bedrock Units.--The oldest sedimentary bedrock unit encountered in this study is the Camillus Shale of Silurian age (fig. 3), which occurs only in the northern part of the Buffalo area. This unit has been described by LaSala (1968) as a gray, red, and green thin-bedded shale containing massive mudstone; the unit also contains beds and lenses of gypsum approaching 5 ft in thickness. Subsurface information indicates a dolomitic mudrock to be interbedded within the unit also. The Camillus Shale, estimated to be about 400 ft in thickness, dips southward throughout the area at approximately 40 ft/mi. Information from gypsum miners indicates that the dip of the formation is undulatory within a range of a few feet.

Two other units of Silurian age overlie the Camillus Shale--the Bertie Limestone and the overlying Akron Dolomite. The Bertie Limestone is a gray and brown dolomite with some interbedded shale; the Akron Dolomite is a greenish-gray and buff fine-grained dolomite (LaSala, 1968). The Bertie Limestone, the thicker of the two units, ranges from 50 to 60 ft thick, whereas the Akron Dolomite is estimated to be 8 ft thick. Both formations dip southward, as does the underlying Camillus Shale.

The Onondaga Limestone of middle Devonian age overlies this limestone-dolomite unit; the two units are separated by an unconformity or an erosional contact. The Onondaga Limestone consists of three members. The lowest, which overlies the Akron Dolomite, is a gray, coarse-grained limestone generally a few feet thick. This member, according to Buehlor and Tesmer (1963), grades laterally into reef deposits, thereby increasing its thickness. The middle member consists of a gray limestone and blue chert and reaches a thickness of 40 to 45 ft. The upper member is a dark gray to tan limestone ranging in thickness from 50 to 60 ft. The overall thickness of the Onondaga Limestone is approximately 110 ft.

The Marcellus Shale overlies this limestone unit; the formation is described by LaSala (1968) as being black and fissile. The unit ranges in thickness from 30 to 55 ft and dips generally southward at 40 ft/mi. The uppermost unit within the study area is the Skaneateles Formation. It is olive-gray to dark-gray and black, fissile shale with calcareous beds. The lower 10 feet of the unit is gray limestone. Total thickness is 60 to 90 feet. This unit is found in the southernmost part of the study area.



Base from USGS, 1974 Geology from LaSala, 1968

Figure 3. Bedrock geology of the Buffalo area. (Modified from La Sala, 1968.)

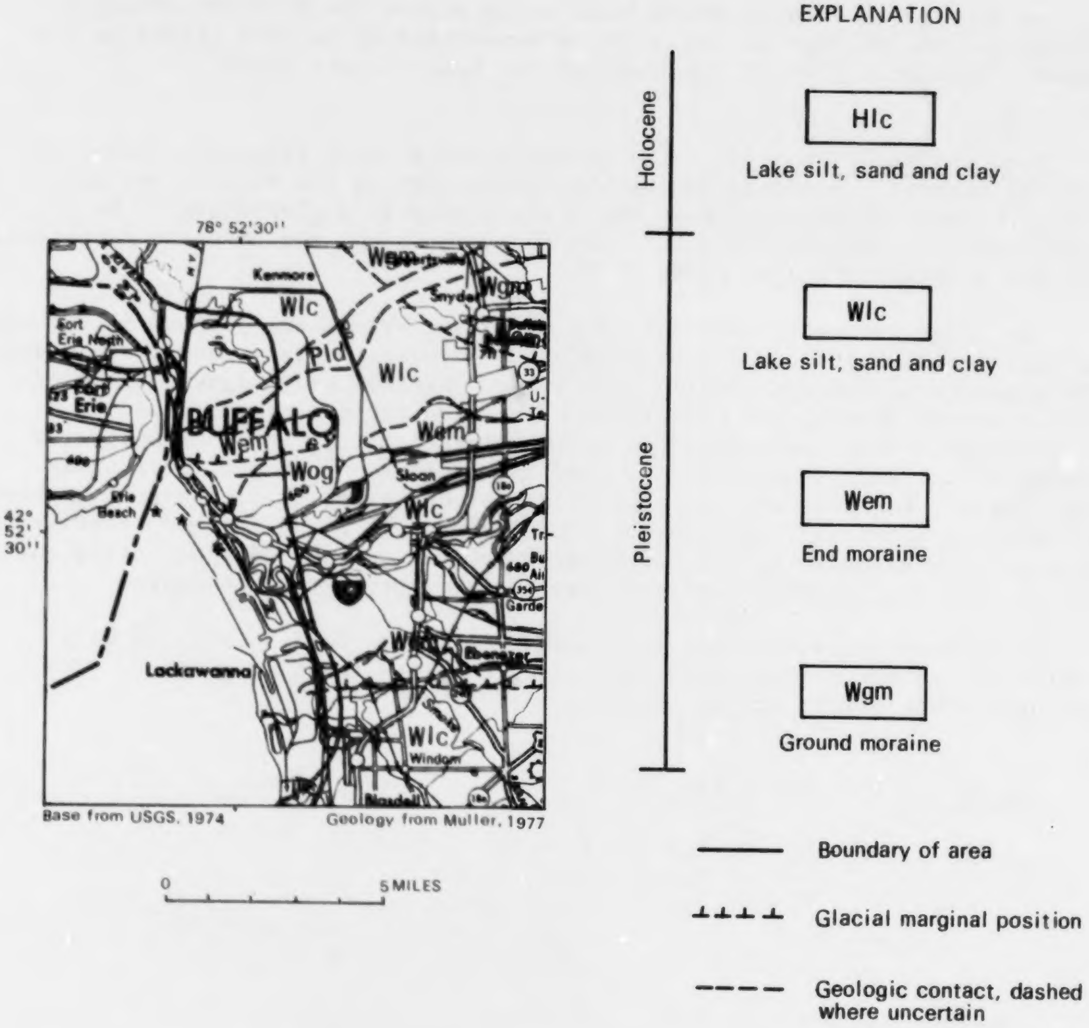


Figure 4. Surficial geology of the Buffalo area. (Modified from Muller, 1977.)

No additional data on the bedrock units within the Buffalo area were obtained. The geology of the units is summarized by La Sala (1968) in his report about ground-water resources of the Erie-Niagara basin.

Unconsolidated Deposits.--The unconsolidated units (fig. 4) consist of glacial material deposited during the latter part of the Pleistocene epoch. The main unconsolidated unit in the Buffalo area is a glaciolacustrine clay-sand deposit consisting of silt, fine to medium sand, and clay and containing laminae of alternating sand and clay.

Two other unconsolidated deposits of lesser extent are present in the area--an end-moraine deposit and a small area of outwash, terrace, and delta gravel. The end-moraine material, which consists of ablation and lodgment tills or poorly sorted gravel that contain more than 20 percent carbonate and crystalline clasts, was deposited at the edge of an ice sheet by meltwater either at the end of an advance or during a stillstand of glacial retreat. The outwash, terrace, and delta gravels, which consist of well-sorted pebbles and cobbles with sand, contain more than 30 percent carbonate and crystalline clasts. The material was deposited by meltwater streams forming coalescent aprons near the ice sheet or as stream terraces or terrace remnants.

Three test holes were drilled to bedrock in the Buffalo area to help define the subsurface geology; their locations are shown in plate 1. The geologic descriptions are as follows:

Boring no.	Depth (ft)	Description
SA-9	0 - 1.5	Topsoil
	1.5 - 6.5	Sand, brown
	6.5 - 11.5	Clay, sandy, with gravel, dark brown
	11.5 - 25.5	Clay, sand with clay, gray, wet at 11.5 ft
	25.5	Bedrock
SA-10	0 - 1.5	Topsoil
	1.5 - 6.5	Clay, sandy, red
	6.5 - 11.0	Clay, some gravel, red
	11.0	Bedrock, material was dry throughout
SA-11	0 - 16.5	Fill, black, ground water at 10 ft
	16.5 - 21.5	Clay, silty, green
	21.5 - 36.5	Clay, silty, gray-green
	36.5 - 60.0	Clay, silty, pinkish-gray
	60.0	Bedrock

The geologic information from these test holes, combined with the data from the waste-disposal sites, enables a general characterization of the area.

The unconsolidated deposits, primarily the glaciolacustrine clay, tend to decrease in thickness toward the east and north, where bedrock rises to less than 5 ft below land surface. Also, the clay unit is generally less than 2 ft below land surface except where it has been removed by landfilling and waste-disposal operations or urbanization.

Aquifer Lithology and Water-Bearing Characteristics

The ground-water system within the Buffalo area consists of a fractured bedrock aquifer and an overlying aquifer of unconsolidated deposits.

Bedrock aquifer.--The bedrock aquifer consists of all the bedrock units discussed previously. The main sources of water are the fractures and solution cavities. The specific-capacity and transmissivity values of selected bedrock aquifer units are shown below.

Bedrock unit[1]	Specific capacity[2] (gal/min)/ft		Transmissivity[2] (gal/d)/ft	
	Min	Max	Min	Max
Akron Dolomite	2	13	4,000	25,000
Camillus Shale	4	83	7,000	70,000

[1] Position of units is shown in figure 3.

[2] Data from LaSala (1968)

The specific capacity of a well is the rate of discharge of water from the well divided by the drawdown of the water level within the well. If the specific capacity is constant except for the time variation, it is roughly proportional to the transmissivity of the aquifer. Transmissivity is the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

The data above indicate that these two properties differ considerably within and among the units. This variation reflects the amount and size of the fractures and solution cavities.

Unconsolidated aquifer.--The unconsolidated aquifer consists of a glaciolacustrine clay and sand and gravel deposits. The thicker unit is the glaciolacustrine clay. The test drilling during the summer of 1982 encountered the water table at various depths within the clay, and saturated sand stringers up to 3 inches thick were common. These stringers were not large, however, and generally thinned out within a few feet.

A seasonal water table above the clay unit was observed during wet periods but not during the summer. This water table is formed by the ponding of infiltrated precipitation above the relatively impermeable clay. As the water mounds upward, gradients toward natural or manmade topographic lows develop and eventually discharge to nearby surface-water bodies. As the season becomes drier and warmer, vegetation increases and takes up the remaining ground water through transpiration.

The hydrologic properties of the unconsolidated aquifer within the Buffalo area are also described in consultants' reports for Buffalo Color Corporation (sites 120-122), Bethlehem Steel Corporation (site 118), and the Alltift Landfill (site 162).

The general range of hydraulic conductivity was 0.0328 to 155.8 ft/d. The larger value can be attributed to slag fill material, which would have a considerably greater permeability than the glaciolacustrine clay. A permeability test was performed on a clay sample from the Alltift landfill; the permeability ranged from 1.6×10^{-4} to 1.8×10^{-4} ft/d.

The rate of ground-water movement within the unconsolidated aquifer at the Buffalo Color Corporation (sites 120-122) was calculated and ranges from 0.02 to 0.06 ft/yr.

The direction of ground-water movement in the unconsolidated aquifer is generally toward the major surface-water bodies--Lake Erie, Niagara River, and Buffalo River (fig. 4). The ground-water flow pattern is dissected in the northern part of the area, where impermeable bedrock is less than 5 ft below land surface, as indicated in figure 4. This unsaturated zone diverts the flow northward and southward.

Ground-Water Quality

The quality of ground water in the bedrock aquifer in the Buffalo area has been documented by LaSala (1968), who included maps showing the concentration ranges for sulfate, hardness, and chloride. Sulfate concentrations given in that report ranges from 100 to 500 ppm and hardness (as $CaCO_3$) from 150 to 1,000 ppm; chloride concentrations range from 100 to 1,500 ppm, and specific conductance ranges from 1,000 to 9,000 µmho/cm.

To estimate background water quality in the Buffalo area, a water sample was collected from the unconsolidated deposits in the fall of 1982 and analyzed for priority pollutants. The observation well was on Seneca Street (well SA-9, pl. 1), in the eastern part of the area just east of the Buffalo city line, and was screened above the bedrock contact. The results are given in table 14. Cadmium, lead, and zinc exceeded USEPA drinking-water criteria; minor amounts of some organic compounds were also detected. Additional sampling of the ground water in the unconsolidated aquifer would be needed to define the quality of water in this aquifer in the Buffalo area.

Three substrate samples were collected in the Buffalo area at localities not affected by waste-disposal sites to compare their concentrations of heavy metals with those in substrate samples from waste-disposal sites. Results are given in table 13.

Table 13.--Heavy-metal concentrations in samples from undisturbed soils in Buffalo, N.Y., June 1, 1983
[Locations shown in pl. 1. Concentrations in µg/kg.]

Location	Sample number	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
Forest Lawn Cemetery	SB-1	5,000	8,000	7,000	20,000	100	10,000	31,000
Martin Luther King Park	SB-2	5,000	8,000	10,000	40,000	90	20,000	42,000
Holy Cross Cemetery[1]	SB-3	9,000	30,000	40,000	290,000	280	40,000	160,000

[1] This location is downwind from a major industrial area.

Table 14.--Analyses of a ground-water sample from well SA-9 in the unconsolidated deposits along Seneca Street, West Seneca, N.Y., November 13, 1982.

[Location shown in pl. 1. Concentrations are in µg/L. Dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

Inorganic constituents

Antimony	2	Lead	490†
Arsenic	17	Mercury	--
Beryllium	--	Nickel	210
Cadmium	22†	Selenium	1
Chromium	1	Zinc	53,000†
Copper	160		

Organic compounds

Priority pollutants

Methylene chloride	3.2	Phenol	LT
Toluene	3.9	Naphthalene	LT
Ethylbenzene	LT	Dimethyl phthalate	LT
DDT	0.17†	Diethyl phthalate	19
		Dibutyl phthalate	LT

Nonpriority pollutants

Chlordene	0.19	1,3-Dimethylbenzene[1]	LT
1-Methyl-3-phenoxybenzene[1]	LT	2-Butoxyethanol[1]	LT
1-(2-butoxyethoxy)ethanol[1]	490	1-(1-isobutyl-3-methyl-1-butenyl)-pyrrolidine[1]	LT
2-Ethylhexanoic acid[1]	15.7	2,3,3,4-Tetramethylpentane[1]	LT
Exo-2-chloro-1-methylbicyclo[2.2.1]heptane[1]	LT	Methyl-3,5-di-O-methyl-alpha-D-xylofuranoside[1]	550
Cis-1-bromo-2-chlorocyclohexane[1]	LT	N-Ethylbutanamide[1]	100
Benzenepropanoic acid[1]	67		

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water.

TONAWANDA AREA

Geology

The Tonawanda study area (pl. 2) consists of unconsolidated deposits of clay, sand, and till of Pleistocene and Holocene age overlying Camillus Shale bedrock of Silurian age.

Bedrock Units.--The Camillus Shale is the only bedrock unit encountered in the area. As described previously, it is a gray, red, and green thin-bedded unit with massive mudstone and also contains beds and lenses of gypsum. Thickness of the shale is estimated to be 400 ft but decreases to the north near the contact with the Lockport Dolomite.

Unconsolidated Deposits.--The unconsolidated units consist of glacial material deposited during the latter part of the Pleistocene epoch and lacustrine material deposited during the early Holocene. The distribution of unconsolidated deposits in the area is shown in figure 5.

The Pleistocene materials are similar to those in the Buffalo area except for a ground-moraine deposit, which consists mainly of lodgment till, silty clay till, and sandy till. This deposit was formed by the transport and deposition of material beneath the southward flowing continental ice sheet (Muller, 1977) and is thus compacted and relatively impermeable.

The northern part of the area contains a Holocene lacustrine deposit consisting primarily of clay with stringers of sand and silt. Most stringers are less than 3 inches thick and are discontinuous throughout the area.

The U.S. Geological Survey drilled five test holes in 1982 to obtain additional data on the subsurface geology of the area. (Locations of these holes, SA-4 through SA-8, are shown on pl. 2.) The geologic logs are as follows:

Boring No.	Depth (ft)	Description
SA-4	0 - 1.5	Topsoil
	1.5 - 6.5	Clay, sand, green
	6.5 - 18.5	Clay, pink
	18.5	Bedrock
SA-5	0 - 6.5	Road fill, rubble
	6.5 - 19.0	Clay, pink
	19.0 - 24.5	Sand
	24.5	Bedrock
SA-6	0 - 3.0	Topsoil, rubble
	3.0 - 28.0	Clay, pink
	28.0 - 44.0	Sand, silty
	44.0	Bedrock
SA-7	0 - 1.5	Topsoil
	1.5 - 16.5	Clay, gray-green
	16.4 - 19.0	Clay, pink
	19.0 - 27.0	Clay, sandy pink
	27.0	Bedrock

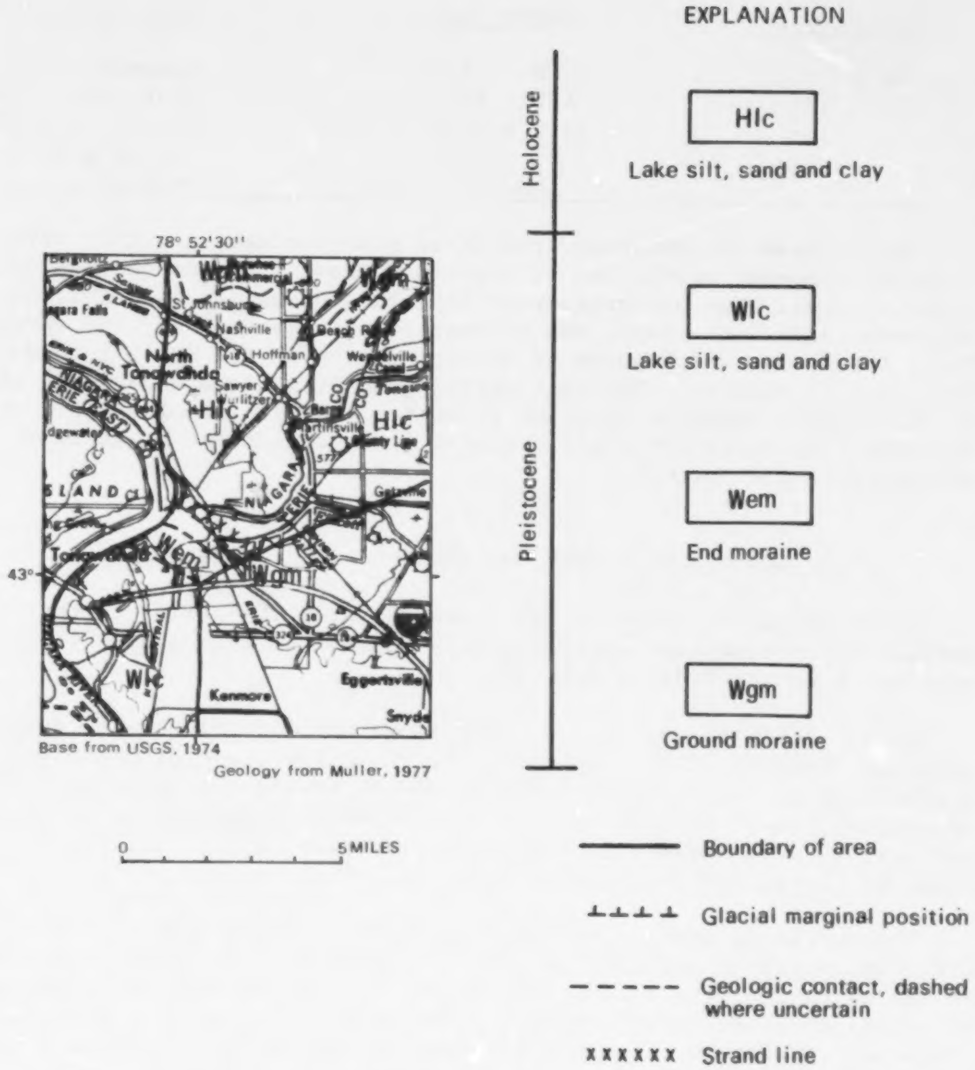


Figure 5. Surficial geology of the Tonawanda area.

Boring No.	Depth (ft)	Description
SA-8	0 - 1.5	Topsoil
	1.5 - 31.5	Clay, red
	31.5 - 63.0	Clay, red, interbedded with gravel
	63.0	Bedrock

The information obtained from these test borings, together with the data from the disposal sites, can be used to characterize the geology of the area in general terms. The unconsolidated deposits, primarily the Pleistocene and Holocene lacustrine clays, are encountered within 6 ft of land surface. Their thickness, which seems to be dependent upon the depth to bedrock, ranges from 18.5 to 63.0 ft. The test drilling confirmed the boundaries of the unconsolidated deposits as drawn by Muller (1977). Also, the Pleistocene and Holocene clay units are similar except in color and the presence of sand stringers in the latter.

Aquifer Lithology and Water-Bearing Characteristics

The hydrologic system of the Tonawanda area is similar to that of the Buffalo area--a bedrock aquifer consisting of Camillus shale overlain by an aquifer of unconsolidated deposits.

Water within the bedrock aquifer flows through the joints, fractures, and solution cavities within the unit. The Camillus Shale is estimated to have a transmissivity ranging from 7,000 to 70,000 (gal/d)/ft (LaSala, 1968). Regionally, under nonpumping conditions, ground water in the shale moves west and south. Ground water in shallow bedrock discharges into Tonawanda Creek, Ellicott Creek, and the Niagara River (pl. 2)

The overlying aquifer consists of unconsolidated morainal and clay deposits. The morainal material is generally a clayey till whose permeability is as low as that of the lacustrine clays. During the test drilling, ground water was encountered at various depths within the clayey units; also encountered were stringers of permeable sand that initially yielded considerable amounts of water. The yield diminished with time, however, as the stringers became dewatered.

The low permeability of the deposits causes a seasonal perched water table, similar to that of the Buffalo area, during periods of high precipitation. This water table discharges into areas of low topography and eventually into nearby surface-water bodies.

The hydrologic properties of the unconsolidated aquifer have been discussed in several consultant reports on the geohydrology of the major disposal sites; these reports are cited in the site descriptions (appendix B).

Permeability tests done by consultants on clay samples from several of the disposal sites indicate that the vertical permeability is low, ranging from 10^{-6} to 10^{-8} cm/s. This is probably the reason for the nearly steady water levels in monitoring wells screened in this aquifer. Horizontal permeability may be orders of magnitude greater than vertical permeability.

The direction of ground-water movement in the aquifer is generally toward the major surface-water bodies--the Niagara River and Ellicott, Sawyer, and Tonawanda Creeks (pl. 2).

Ground-Water Quality

The chemical quality of ground water in the bedrock aquifer has been investigated by LaSala (1968). Concentrations of sulfate ranged from 100 to 1,000 mg/L and hardness (as $CaCO_3$) from 1,500 to 3,000 mg/L. Chloride concentrations ranged from 100 to 1,500 mg/L, and specific conductance from 1,500 to 9,000 µmho/cm at 25°C.

Water samples were collected in the fall of 1982 from five observation wells (SA-4, 5, 6, 7, and 8; locations shown in pl. 2) screened in the unconsolidated deposits above the bedrock contact and were analysed for priority pollutants. Four of the wells were along the eastern edge of the area and one was adjacent to the Niagara River. Results of the analyses (table 16) indicate that concentrations of cadmium, lead, and zinc exceeded USEPA drinking-water criteria and NYS ground-water standards. A few organic compounds were detected, all in minimal quantities except methylene chloride and toluene. Chlordane was detected at a well along the eastern edge of the area, and α-chlordane was detected at one well adjacent to the Gratwick-Riverside Park site along the Niagara River. Additional sampling of ground water in the aquifer would be needed to define its quality in the Tonawanda area.

Three substrate samples were collected at localities not affected by waste-disposal sites in the Tonawanda area and were analyzed for heavy metals; results are given in table 15.

Table 15.--Heavy-metal concentrations in substrate samples from undisturbed soils in Tonawanda, N.Y., May 31, 1983 and June 1, 1983.
[Concentrations in µg/kg. Locations shown in pl. 2]

Location	Sample number	Cadmium	Chromium	Copper	Lead
Beaver Island State Park	SB-4	4,000	8,000	10,000	100,000
Mount Olive Cemetery	SB-5	4,000	20,000	20,000	30,000
Oppenheim Park	SB-6	1,000	20,000	20,000	20,000
Ellicott Creek Park	SB-7	4,000	10,000	20,000	20,000

Location	Sample number	Mercury	Nickel	Zinc
Beaver Island State Park	SB-4	200	20,000	57,000
Mount Olive Cemetery	SB-5	120	30,000	58,000
Oppenheim Park	SB-6	110	20,000	59,000
Ellicott Creek Park	SB-7	120	20,000	47,000

Table 16.--Analyses of ground-water samples from wells in the unconsolidated deposits along the Niagara River, Tonawanda, N.Y., November 13, 1982

[Concentrations are in μg/L, dash indicates that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit. Locations shown in pl. 2.]

	Well number and depth below land surface (ft)		
	(SA-4) Whitmer Road	(SA-5) Gratwick Park	(SA-6) Niagara Falls Boulevard
pH	6.9	6.6	6.8
Specific conductance (μmho/cm)	975	2,590	985
Temperature (°C)	18.2		
Inorganic Constituents			
Antimony	--	--	--
Arsenic	2†	2†	1†
Beryllium	--	--	--
Cadmium	12†	20†	10
Chromium	1	1	1
Copper	65	33	18
Lead	180†	220†	120†
Mercury	--	--	--
Nickel	33	18	18
Selenium	--	--	--
Zinc	16,000†	1,400	630
Organic Compounds			
Priority pollutants			
Methylene chloride	42	110	210
Toluene	41	170	410
Ethylbenzene	LT	LT	25
Dibutylphthalate	LT	11	--
Phenol	5.6†	--	--
Pentachlorophenol	LT	--	--
α-chlordane	--	1.08†	--
Nonpriority pollutants			
Diethylphthalate	--	8.2	--
Methylcyclopentane[1]	LT	--	14
3-Methylpentane[1]	LT	--	--
1-Methylpentylhydroperoxide[1]	--	--	6.3
2,2,3-Trimethylbutane[1]	--	--	LT
2-Methyl-1-propene	-	LT	--
Hexane	41	--	40
2,4-Dimethylpentanol[1]	LT	--	--
Chlordene		0.05	1.6

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standard for maximum concentration in ground water.

Table 16.--Analyses of ground-water samples from wells in the unconsolidated deposits along the Niagara River, Tonawanda, N.Y., November 13, 1982 (continued)

[Concentrations are in μg/L, dash indicates that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit. Locations shown in pl. 1.]

	Well number and depth below land surface (ft)		
	(SA-4) Whitmer Road	(SA-5) Gratwick Park	(SA-6) Niagara Falls Boulevard
Organic compounds (continued)			
Nonpriority pollutants (continued)			
1,3-Dimethylbenzene[1]	--	--	LT
2-Ethylhexanoic acid[1]	--	--	140
Octanoic acid[1]	--	--	47
Nonanoic acid[1]	--	--	22
4-Hydroxy-3,5-dimethylbenzaldehyde[1]	--	--	LT
2,2,4-Trimethylpentane[1]	15	--	--
Methylcyclohexane[1]	28	--	--
2,5-Dimethylhexane[1]	40	--	--
2,4-Dimethylhexane[1]	43	--	--
Ethylcyclopentane[1]	7.8	--	--
2,3,3-Trimethylpentane[1]	19	--	--
2-Methylheptane[1]	48	--	--
3-Methylheptane[1]	25	--	--
3,3-Dimethylhexane[1]	14	--	--
2,3,4-Trimethylhexane[1]	15	--	--
2-Methyl-4-heptanone[1]	18	--	--
1,4-Dimethylbenzene[1]	26	--	--
1,2-Dimethylbenzene[1]	4.7	--	--
2-Heptanone	3.1	--	--
2,2,4,4-Tetramethyl-3-pentanone[1]	94	--	--
2,6-Dimethyl-4-heptanol[1]	5.4	--	--
2-Decanone[1]	40	--	--
2-Decanol[1]	LT	--	--
1,4-Dioxane[1]	61	--	--
4-Chloro-trans-cyclohexanol[1]	7.4	--	--
5-Ethyldihydro-2(3H)-furanone[1]	7.2	--	--
4-Methylbenzoic acid[1]	LT	--	--
Compound potentially of natural origin			
Hexanoic acid[1]	--	--	160
2-Hexanone[1]	5.4	--	--

Table 16.--Analyses of ground-water samples from wells in the unconsolidated deposits along the Niagara River, Tonawanda, N.Y., November 13, 1982 (continued)

[Concentrations are in μg/L, dash indicates that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit. Locations shown in pl. 2.]

	Well number and depth below land surface (ft)	
	(SA-7) Shawnee Road	(SA-8) Department of Transportation
pH	7.3	6.6
Specific conductance (μmho/cm)	585	2,400
Temperature (°C)		
Inorganic Constituents		
Antimony	--	--
Arsenic	2†	7†
Beryllium	--	--
Cadmium	10	22†
Chromium	2	1
Copper	40	18
Lead	290†	210†
Mercury	--	--
Nickel	24	8
Selenium	--	--
Zinc	690	3,800
Organic Compounds		
Priority pollutants		
Methylene chloride	30	3.6
Toluene	15	5.1
Ethylbenzene	--	LT
Dimethyl phthalate	--	130
Dibutylphthalate	--	2
1,4-Dioxane[1]	--	LT
Nonpriority pollutants		
Diethylphthalate	--	LT
Methylcyclopentane[1]	3.8	--
1-Methylpentylhydroperoxide[1]	--	1.4
Chlordene	0.13	--
Butyl-2-methylpropyl/phthalate	--	86
2-(2-Butoxyethoxy)-ethanol	--	140
1,1-Oxybis(2-ethoxy)ethane[1]	--	6
Acetic acid, 1-methylpropylester[1]	--	550
2-Pentanol[1]	--	LT
1-Chloro-2-ethenyl-methyl-cyclopropane[1]	--	LT
1,3-Isobenzofurandione	--	LT

NIAGARA FALLS AREA

Geology

The Niagara Falls study area (pl. 3) consists of unconsolidated Pleistocene and Holocene-age deposits of till, lacustrine clay and silt, and alluvial fine sand underlain by dolomite of middle Silurian age. The bedrock units studied are the Lockport Dolomite and the upper part of the Rochester Shale. The bedrock stratigraphy beneath this area is shown in figure 6; the distribution of unconsolidated deposits is shown in figure 7.

Bedrock Units.--The Lockport Dolomite is a hard and resistant calcium-magnesium carbonate sedimentary rock that crops out in the study area and forms the Niagara Escarpment north of Niagara Falls. In the northern part of the area, erosion has removed much of its upper part, leaving a thickness of only 30 ft at the escarpment, but the unit thickens to the south and, in the southern part of the city of Niagara Falls, it is 155 ft thick.

In 1982, the U.S. Geological Survey installed 11 observation wells in the upper part of the dolomite in the city of Niagara Falls and two open-hole wells through the entire thickness of the Lockport Dolomite adjacent to the gorge face. (Locations of the wells are shown on pl. 3.)

Unconsolidated Deposits.--A relatively thin layer of unconsolidated deposits, 3 to 35 ft thick, overlies bedrock (fig. 7). Along the upper Niagara River, in the southern part of Niagara Falls, fill and (or) alluvial fine sand overlie clay and till or bedrock; elsewhere lacustrine clay and silt overlie the bedrock. In the middle and northern parts of the area, a layer of till 5 to 20 ft thick overlies bedrock. The till consists of a silty clay or sandy matrix that was formed by the transport and lodgment of material beneath the flowing continental ice sheet (Muller, 1977) and is thus compacted and relatively impermeable.

In 1982, the U.S. Geological Survey drilled three test holes (SA-1, SA-2, and SA-3) to the top of the bedrock; the geologic logs are as follows:

Boring no.	Depth below land surface (ft)	Description
SA-1	0 - 3.0	Topsoil and fill
	3.0 - 18.0	Clay, pink
	18.0 - 24.0	Sand, clayey, with gravel
	24.0	Bedrock
SA-2	0 - 1.5	Topsoil
	1.5 - 6.5	Fill, black
	6.5 - 24.0	Clay, pink
	24.0 - 34.0	Clay and gravel (till?)
	34.0	Bedrock
SA-3	0 - 1.5	Topsoil
	1.5 - 16.5	Clay, pink
	16.5 - 20.0	Clay, pink, some gravel
	20.0	Bedrock

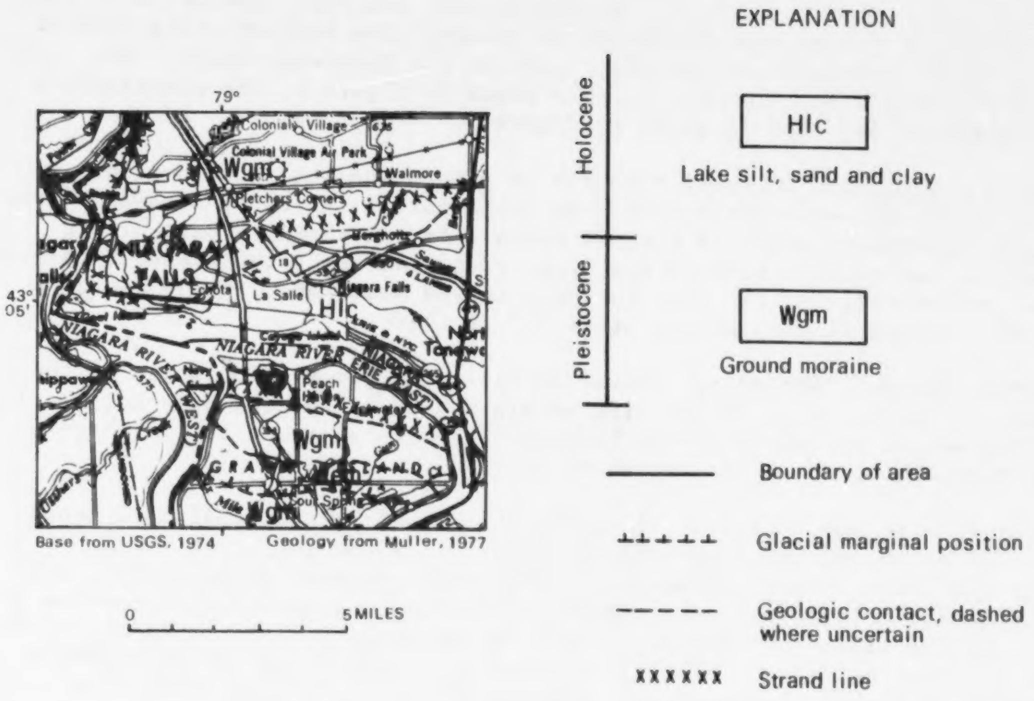
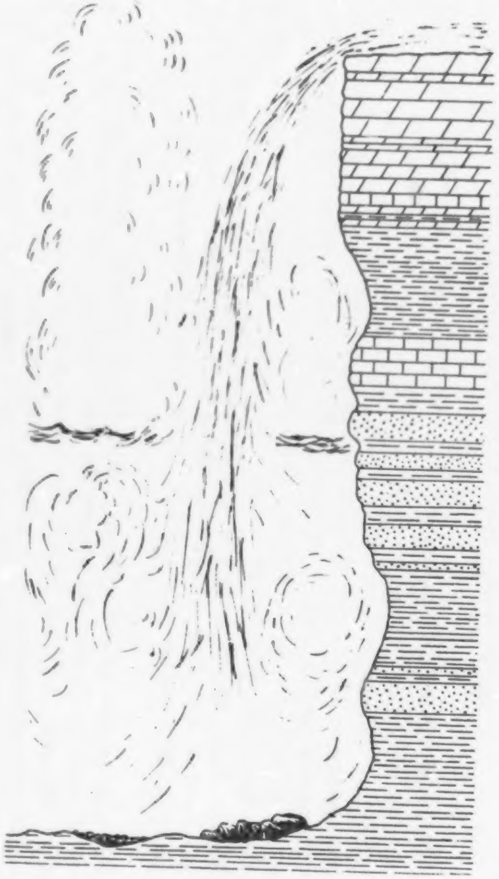


Figure 6. Geologic column of the Niagara Falls area.



System		Group	Formation	Thickness 1/ (feet)	Description
Silurian	Middle		Lockport Dolomite	150	Dark-gray to brown, massive to thin-bedded dolomite, locally containing algal reefs and small, irregularly shaped masses of gypsum. At the base are light-gray, coarse-grained limestone (Gasport Limestone Member) and gray shaly dolomite (DeCew Limestone Member of Williams, 1919).
		Clinton	Rochester Shale	60	Dark-gray calcareous shale weathering light-gray to olive.
			Irondequoit Limestone	12	Light-gray to pinkish-white coarse-grained limestone.
			Reynales Limestone	10	White to yellowish-gray shaly limestone and dolomite.
			Neahga Shale of Sanford (1933)	5	Greenish-gray soft fissile shale.
	Lower	Albion	Thorold Sandstone	8	Greenish-gray shaly sandstone.
			Grimsby Sandstone of Williams (1914)	45	Reddish-brown to greenish-gray cross-bedded sandstone interbedded with red to greenish-gray shale.
			Unnamed unit	40	Gray to greenish-gray shale interbedded with light-gray sandstone.
			Whirlpool Sandstone	20	White, quartzitic sandstone.
Ordovician	Upper		Queenston Shale	1,200	Brick-red sandy to argillaceous shale.

1/ Average figure for area. Thickness at falls is not necessarily the same.

Figure 7. Surficial geology of the Niagara Falls area

The Geological Survey drilled six other test holes (RMP-2 through RMP-6) along the Robert Moses Parkway in 1982. Test-hole locations are shown on pl. 3.

Aquifer Lithology and Water-Bearing Characteristics

The ground-water system within the Niagara Falls area (pl. 3) consists of the Lockport Dolomite and an overlying aquifer of unconsolidated deposits, as shown in the generalized geologic column of the area in figure 6.

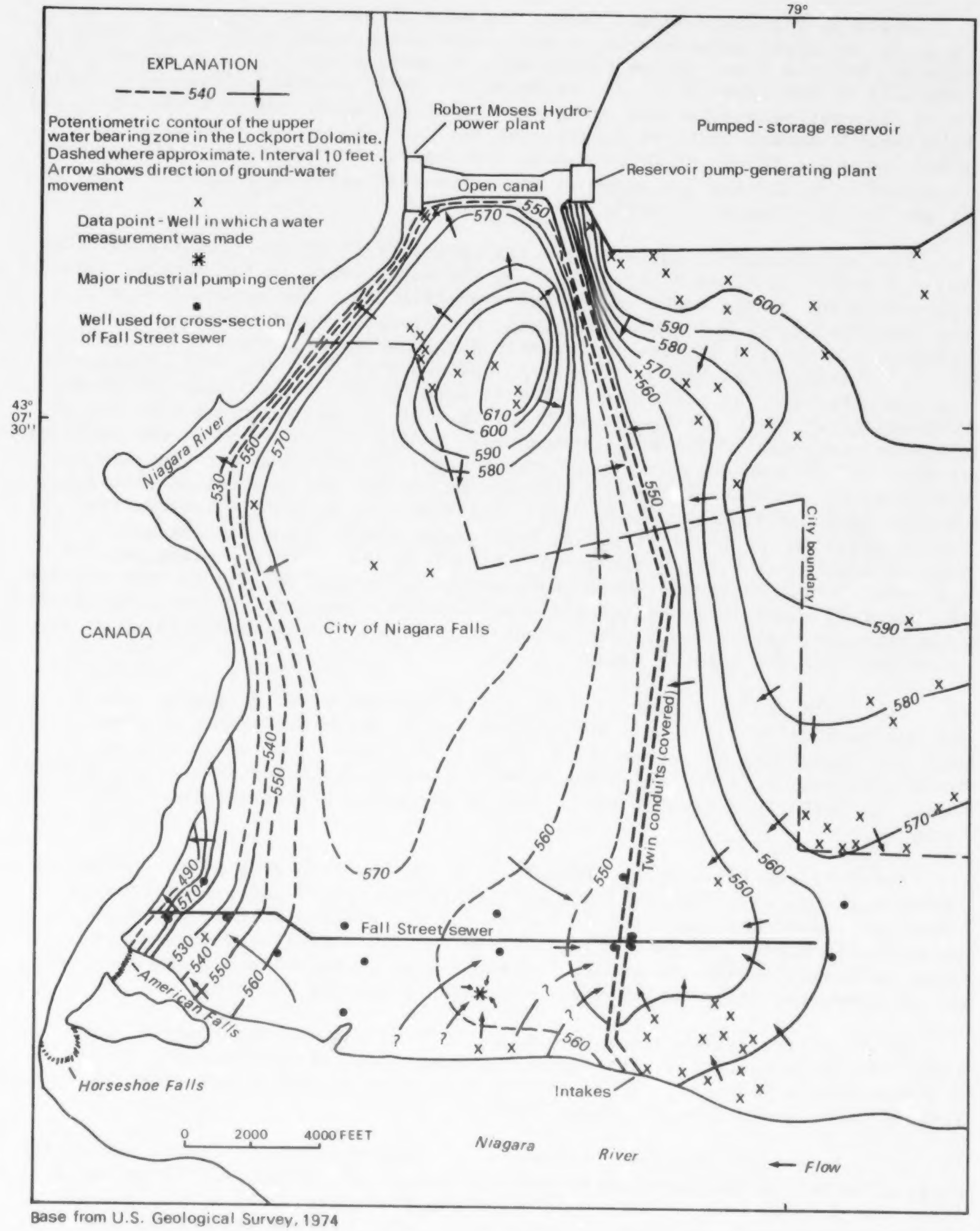
Bedrock aquifer.--The Lockport Dolomite consists of a predominantly fine crystalline matrix with some poorly connected vugs, mostly in the upper part, but few primary openings through which ground water can move. Significant ground-water movement occurs in secondary openings such as joints and fractures, and these may have been slightly widened by solution. The secondary openings are more numerous in the upper part of the dolomite as a result of weathering. Some joints and fractures have developed in the underlying Rochester Shale (fig. 6), but not nearly to the extent as in the Dolomite because the shale is less brittle. Little hydrologic information on the deeper rock units is available.

Most of the ground-water movement occurs along the horizontal bedding joints of the Lockport, in which Johnston (1964) identified seven major zones. Some movement also occurs in other thin-bedded zones (0.5 to 4 inches thick), which tend to be weaker and more likely to fracture than the more massive beds, which are 2 to 10 ft thick. Johnston (1964) noted that major water movement occurs within thin-bedded zones that are overlain by thick, massive beds.

Movement of ground water in vertical joints is greatest in the upper 10 to 15 ft of the Dolomite (weathered zone) and in the vicinity of the gorge wall. Tension-release joints have formed to about 200 ft inland from the gorge wall since the erosion of the supporting rock mass. These joints are probably significant avenues for downward flow of ground water to the Niagara River. The vertical joints near the gorge wall may explain the lack of seepage springs from the dolomite along the gorge wall. Ground water has been observed to seep out along the top of the underlying Rochester Shale and other deeper rock units.

Water levels in wells installed in the Lockport Dolomite at depths of 5 to 20 ft below the water table were used to compile a map showing the potentiometric surface of the upper water-bearing zones (fig. 8). The differences among potentiometric heads in deeper water-bearing zones could not be defined because not enough wells could be installed in each water-bearing zone nor grouted to seal off the effects of other zones. Johnston (1964) described the water-bearing bedding joints as being separated by essentially impermeable rock and considered them as distinct artesian aquifers. The horizontal joints are probably connected to some extent by vertical fractures, but little information is available to determine the extent of hydraulic connection.

An unlined storm-sewer tunnel, the Falls Street Tunnel, runs through the upper part of the Lockport Dolomite in the Niagara Falls area (fig. 8). The tunnel starts 1 mi east of the power conduits and 0.7 mi north of the upper Niagara River and extends westward to a gorge interceptor tunnel near the gorge wall just north of American Falls. Flow is then pumped to the Niagara Falls Wastewater Treatment Plant. The Tunnel is 3.5 mi long and slopes at an average rate of 20 ft/mi toward the gorge face.


EXPLANATION
540
Potentiometric contour of the upper water bearing zone in the Lockport Dolomite. Dashed where approximate. Interval 10 feet. Arrow shows direction of ground-water movement
x
Data point - Well in which a water measurement was made
*
Major industrial pumping center
●
Well used for cross-section of Fall Street sewer
79°
43° 07' 30''
Robert Moses Hydro-power plant
Pumped-storage reservoir
Reservoir pump-generating plant
Open canal
570
550
600
590
580
570
560
610
600
590
580
Niagara River
530
550
570
CANADA
City of Niagara Falls
City boundary
550
590
580
Twin conduits (covered)
540
550
570
560
550
560
550
570
490
510
530
540
550
560
Fall Street sewer
American Falls
?
560
Horseshoe Falls
Intakes
0 2000 4000 FEET
Niagara River
Flow

Base from U.S. Geological Survey, 1974

Figure 8. Potentiometric surface of the upper water-bearing zones of the Lockport Dolomite and location of bedrock wells in the Niagara Falls area.

South of the Falls Street Tunnel and east of the power conduits, ground water in the upper water-bearing zones of the Lockport Dolomite moves northwest from the Niagara River to the tunnel and the power conduits. This reach of the tunnel is in the upper 15 ft of the Dolomite, which Johnston (1964) described as being the most permeable zone owing to weathering, small solution cavities, and relatively abundant vertical joints. At the east end of the tunnel, water levels at wells NFB-9 and 10 were 3 to 5 ft above the top of the tunnel, which indicates a relatively low slope in potentiometric surface, ranging 0.3 to 0.8 ft per 100 ft between the wells and the tunnel.

The potentiometric surface near the intersection of the conduits and the Falls Street Tunnel may be controlled by the water level in the forebay canal of the powerplant at the north end of the area (fig. 8). The backfill on top of the conduits may be more permeable than the dolomite, which would create a hydraulic connection between the forebay canal and conduit system. Water-level altitudes measured on March 2, 1983, at wells NFB-11, -12, and -13 adjacent to the conduits near the Falls Street Tunnel were 547.91, 546.41, and 547.80 ft, respectively. These altitudes are below that of the weir control (560 ft) at the sump station at Royal Ave., which would enable ground water in the backfill to move into the aqueducts if the water level were above 560 ft. Because the ground-water altitude in the backfill was below the weir control on that date, no flow into the conduits occurred at that time. A possible discharge area for ground water in the backfill may be the forebay canal, in which the water level usually fluctuates between 541 and 546 ft during the winter. During periods of low water levels in the forebay canal, ground water may be able to flow through the backfill above the conduits and discharge into the canal. Thus, the direction of ground-water flow in the immediate area may oscillate according to the water level in the forebay canal.

The Falls Street Tunnel is a significant ground-water discharge area in the vicinity of the conduits, where ground-water seepage (estimated 6 Mgal/d) into the tunnel has been observed at pipe joints where the tunnel crosses the conduits (Camp, Dresser, and McKee, 1982). Lesser ground-water seepage, mostly along the northern wall, has been observed along the entire length of the tunnel.

North of the Falls Street Tunnel and more than 1 mi east of the conduits, ground water flows southward from the Niagara Escarpment and pumped-storage reservoir toward the Falls Street Tunnel and the Niagara River. North of the Falls Street Tunnel and less than 1 mi east of the conduits, ground water also flows southwest toward the tunnel. Along a 1-mi-wide band along the east side of the conduits, ground water moves westward toward the conduits.

South of the Falls Street Tunnel and 0.75 mi west of the conduit, an industrial pumping center withdraws large quantities of ground water (2,000 to 4,000 gal/min). Johnston (1964) reports that part of the pumped water is induced river water from the Niagara River.

Water-level data are insufficient to indicate the effects of the industrial pumping center on the upper water-bearing zone of the dolomite. If the well field has a large cone of influence affecting the upper water zones, ground water probably moves radially into the well field. If the well field does not greatly effect the upper water-bearing zone, however, ground water may flow north-northeast from the river toward the conduits.

Approximately 0.75 mi west of the conduits, water levels in the shallow bedrock wells (NFB-7 and NFB-8, pl. 3) on either side of the Falls Street Tunnel were 20 ft above the top of the tunnel in December 1982, indicating that vertical downward flow of ground water into the tunnel is impeded by the massive, relatively unfractured rock units. West of the conduits, the tunnel dips below the fractured layer (upper 10 to 15 ft of the Lockport Dolomite) and penetrates less fractured and less weathered dolomite. In this area, ground water in the upper water-bearing zone flows over the top of the tunnel. Adjacent to shallow well NFB-7, a deeper well (NFB-7A) was installed and screened at the same depth as the bottom of the tunnel. The water level in the deeper well was 17.5 ft lower than that in the adjacent shallow well, which suggest that west of the conduits, the tunnel drains the water-bearing zones it intercepts but probably has little effect on the zones above or below. The same phenomenon was seen at another pair of wells (NFB-5 and 5A) 1.5 mi west of the conduits, in which the water level in the deeper well (NFB-5A) was 9 ft lower than that in the shallow well (NFB-5).

From 0.5 to 1.0 mi west of the industrial pumping center, water from the Niagara River recharges the Lockport Dolomite and flows northwestward to discharge at the gorge wall. Wells adjacent to the Niagara River at Prospect and Terrapin Points reveal a steeply declining potentiometric surface toward the Niagara River in the gorge. The steep potentiometric gradient within 200 ft of the gorge wall is probably due to the large drop of the river at the falls and the presence of vertical stress-release joints in the bedrock that allow ground water to move downward toward the lower river elevation.

In the northwest part of Niagara Falls, ground water flows radially outward from the apex of a ground-water mound south of the forebay canal. Discharge areas include the Niagara River to the west and northwest, the forebay canal to the north, the conduits to the east, and the city to the south. (The central part of the city has little water-level information to determine ground-water flow paths). A ground-water divide trending roughly north-south runs through the central part of the city. Ground water west of the divide flows toward the Niagara River, and ground water east of the divide flows east-southeast toward the conduits or possibly south to the industrial pumping center.

Unconsolidated aquifer.--The unconsolidated deposits (fig. 7) consist of till, lacustrine silt and clay, and alluvial fine sand overlying bedrock. The till has pebble to cobble clasts embedded in a clayey silt matrix. Permeability of till and lake deposits is low. During the test drilling of 1982, ground water was usually encountered 5 to 15 ft below land surface. The unconsolidated deposits were unsaturated in some areas to the north and along the gorge, where they are thin.

The low permeability of the deposits causes a seasonal water table to form in many places, particularly where fill and coarse-grained material overlie the till or clay. This perched water table usually develops mounds that discharge radially into topographic lows, drainage ditches, and streams.

The hydrologic properties of the unconsolidated aquifer are discussed in consultant reports referred to in the site descriptions in appendix C. The direction of ground-water movement in the aquifer is generally toward the major surface-water bodies--the Niagara River, Bergholtz Creek, and Cayuga Creeks (pl. 3).

Ground-Water Quality

Canadian studies of chemical quality in natural ground water near the river indicate that water in the Lockport Dolomite contains lead and zinc concentrations of 300 to 800 µg/L, with the concentrations increasing with depth (Haynes and Mostaghal, 1982). The lead and zinc are leached from lead- and zinc-sulfide minerals (galena and sphalerite) in the host rock. Natural lead concentrations in most places exceed the USEPA drinking-water criterion of 50 µg/L, whereas zinc concentration is generally less than the Federal and State criteria of 5,000 µg/L. Little information is available about concentrations of other heavy metals in ground water in the dolomite.

To evaluate whether lead and zinc concentrations are natural or man-induced, the highest naturally occurring concentration was doubled, giving a value of 1,600 µg/L. Analytical results above 1,600 µg/L were interpreted to be the result of man's activity.

The presence of natural organic compounds in the rock was evident during drilling, when an acrid oil smell arose during the crushing of the dolomite. Natural gas and oil water have been detected in gas-exploration wells in western New York (Kreidler, 1963). Some of the volatile alkanes of low molecular weight (methane, propane, n-butane, and n-pentane) may occur as natural gas in the Lockport Dolomite.

Ground-water samples were collected and analyzed for USEPA priority pollutants in November and December of 1982 and in January 1983. Three wells (SA-1, SA-2, and SA-3, pl. 3) were screened in the unconsolidated deposits above the bedrock in the eastern part of the Niagara Falls area, five wells (RMP-2 through RMP-6) were screened at or just above the bedrock contact along the Robert Moses Parkway adjacent to the upper Niagara River, four wells (NFB-1 through NFB-4) were installed in the Lockport Dolomite near the gorge wall within the city of Niagara Falls, and nine wells (NFB-5 through NFB-13) were screened in the Dolomite along the Falls Street Tunnel (pl. 3). The results of the analyses are given in tables 17, 18, and 19.

Water from wells SA-1, SA-2, and SA-3 showed cadmium, lead, and zinc concentrations that exceed USEPA criteria for drinking water and the New York State ground-water standards. Methylene chloride and toluene were found in significant concentrations, and other organic compounds were also detected.

Water from wells RMP-2 through RMP-6 had high concentrations of heavy metals, inorganic constituents, and organic compounds, particularly cyanide, methylene chloride, dichloroethylene, chloroform, trichloroethylene, tetrachloroethane, tetrachloroethylene, and toluene. The presence of these compounds in these concentrations can probably be attributed to the disposal practices of the industrial complex bordering the northern part of the Parkway. Cyanide exceeded the USEPA criterion for drinking water; and cyanide, lead, chloroform, trichloroethylene, benzene, and the BHC's exceeded New York State ground-water standards.

A deep and a shallow well were installed in the Lockport Dolomite at each of two sites along the gorge wall. Wells NFB-2 and NFB-4 were screened several feet below the first water-bearing zone encountered, and wells NFB-1 and NFB-3 penetrated the entire thickness of the Lockport and were left as open holes so that a composite sample could be collected from all water-bearing zones in the formation. Generally, the ground-water quality of the deep wells was similar to that of the Niagara River, which may indicate that river water discharges into the dolomite in this area.

Heavy-metal concentrations were high in the shallow wells (NFB-2 and NFB-4) along the gorge wall, especially in well NFB-2, where of cadmium, lead, and zinc (66, 3,600 and 8,700 μg/L, respectively) exceeded USEPA criteria for drinking water and New York State standards for ground water. The mercury concentration in well NFB-3 also exceeded the criterion and standard.

Several organic compounds were present in the wells along the gorge wall. Heptachlor exceeded New York State ground-water standards in wells NFB-1 through NFB-4, and α-BHC exceeded the standard in well NFB-4.

Except for hexane and 2-methyl-1-pentene, both in concentrations of 20 μg/L, the concentration of other organic compounds in well NFB-3 were below 5 μg/L. Higher concentrations and several more compounds were detected in wells NFB-1 and NFB-2. Several of the alkanes and alkenes may be derived from natural gas in the dolomite. Heavy-metal concentrations at wells NFB-11 through NFB-13 were less than the USEPA drinking-water standards, although the zinc concentration (3,500 μg/L) at well NFB-11 is probably higher than in natural ground water in the dolomite.

The largest variety and highest concentrations of organic compounds were detected in ground-water samples from two wells (NFB-11 and NFB-13) along the east side of the conduits. In well NFB-11, toluene, benzene, and trans-1,2-dichloroethylene were detected at 34, 180, and 1,400 μg/L, respectively, and in well NFB-13 at 5.7, 250, and 1,400 μg/L, respectively. A total of 56 organic compounds were found in ground water at well NFB-11, and 24 at well NFB-13.

Ground water from well NFB-12, on the opposite (west) side of the conduits, contained fewer compounds (12) and at generally much lower concentrations. The significant difference in water quality on the two sides of the conduits suggests that ground water does not flow across the conduits, but probably into the backfill material, then northward toward the forebay canal.

The highest heavy-metal concentrations were detected at well NFB-7, where cadmium, lead, zinc, and selenium (89, 3,500, 30,000, and 760 μg/L, respectively) exceeded the USEPA drinking-water standards. A seepage sample collected from the dolomite wall inside the Falls Street Tunnel at 27th Street was found to contain 14,000 μg/L of zinc and 430 μg/L of lead (Camp, Dresser and McKee Eng., 1982). Another seepage sample collected from the tunnel wall 1,600 ft west of 27th Street contained natural levels of zinc (220 μg/L). The high concentrations of heavy metals in the vicinity south of the Falls Street Tunnel and 27th Street may be due to leaching of metal debris from several vacant lots in the area or possibly from leachate moving from the industrial area to the south. More ground-water-level data would be needed to determine the effects of the industrial pumping center on ground-water flow in that area, however.

Several organic compounds were detected in wells NFB-5 through NFB-8 (table 19), but the concentrations were less than 9 μg/L for all constituents except hexane (20 to 160 μg/L) in all four wells and trans-1,2-dichloroethylene (80 μg/L) in well NFB-7. The hexane may have been introduced when used as a solvent to wash the sampling bailer.

Three substrate samples were collected in the Niagara Falls area at localities not affected by waste-disposal sites to compare their concentration of heavy metals with those in substrate samples from waste-disposal sites. Results are given in table 20.

Table 17.--Analyses of ground-water samples from wells in unconsolidated deposits along the Niagara River, Niagara Falls, N.Y., November 10, 1983.

[Locations are shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit.]

	Well number and depth below land surface (ft)		
	(SA-1) I190-I62 Interchange (24.0)	(SA-2) Griffon Park	(SA-3) Airport Triangle (20.0)
pH	7.2		
Specific conductance (µmho/cm)	480		
Inorganic Constituents			
Antimony	--	--	4
Arsenic	1	2	4†
Beryllium	--	--	--
Cadmium	13†	17†	100†
Chromium	1	1	8
Copper	39	31	800
Lead	230†	130†	2,200†
Mercury	--	--	--
Nickel	28	14	980
Selenium	--	--	--
Zinc	3,300	8,900†	640,000†

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standards for maximum concentration in ground water.

Table 17.--Analyses of ground-water samples from wells in unconsolidated deposits along the Niagara River, Niagara Falls, N.Y., November 10, 1983 (continued)

[Locations are shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit.]

	Well number and depth below land surface (ft)		
	(SA-1) I190-I62 Interchange	(SA-2) Griffon Park	(SA-3) Airport Triangle
Organic Compounds			
Priority pollutants			
Methylene chloride	140	7.1	375
Toluene	150	10	230
Ethylbenzene	5.9	LT	4.5
Chloroform	4.2	--	--
Dibutylphthalate	12	0	2.05
Mirex	--	0.21	--
Trans-1,2-dichloroethylene	--	--	23
Nonpriority pollutants			
Diethylphthalate	LT	7.7	2.5
Methylcyclopentane[1]	4.2	5.6	3.7
1-Methylpentylhydroperoxide[1] (or 1-butanol)	2.0	2.0	--
Hexane	--	12	--
Chlordene	--	--	0.08
1,1-Ethanediol, diacetetate[1]	--	--	44
heptane[1]	--	--	240
(2,2-Dimethylpropyl)oxirane[1]	--	--	LT
Methylcyclohexane[1]	--	--	17
Ethylcyclopentane[1]	--	--	7.7
2,3,5-Trimethylpentane[1]	--	--	14
1,2,3-Trimethylcyclopentane[1]	--	--	LT
3-Methyl-2,4-hexadiene[1]	--	--	LT
2,3-Dimethylhexane[1]	--	--	5.8
2-Methylheptane[1]	--	--	44
3,3-Dimethylhexanol[1]	--	--	21
1,4-Dimethyl,cis-cyclohexane[1]	--	--	LT
2,5-Dimethyl-1-hexene[1]	--	--	5.2
2,3,4-Trimethylhexane[1]	--	--	14
(1,1-Dimethylbutyl)oxirane[1]	--	--	2.3
2-Bromohexane[1]	--	--	14
2,6-Dimethylheptane	--	--	18
1,2-Dimethylbenzene[1]	11	--	46
1,4-Dimethylbenzene[1]	5.1	--	15
2,2,4,4-Tetramethyl-3-pentanone[1]	10	--	21

Table 17.--Analyses of ground-water samples from wells in unconsolidated deposits along the Niagara River, Niagara Falls, N.Y., November 10, 1983 (continued)

[Locations are shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit.]

	Well number		
	(SA-1) I190-I62 Interchange	(SA-2) Griffon Park	(SA-3) Airport Triangle
Organic compounds (continued)			
Nonpriority pollutants (continued)			
2-Decanone	--	--	57
2-Ethoxybutane[1]	290	--	270
2-Pentanone[1]	--	--	9.1
4-Chloro-trans-cyclohexanol[1]	--	--	LT
1-chloro-2-ethenyl-1-methylcyclopropane	--	--	LT
3-Ethylhexane[1]	11		--
2-Chloronaphthalene[1]	LT	--	--
2,6-Bis(1,1-dimethylpropyl)-2,5-cyclohexadiene,1,4-dione[1]	5.9	--	--
5-Ethyldihydro-2(3H)-furanone[1]	2.8	--	--
3,5,5-Trimethylhexanoic acid[1]	5.1	--	--
2-(2-Butoxyethoxy)ethanol[1]	93	--	--
Nonanoic acid[1]	85	--	--
1,2-Benzenedicarboxylic acid[1]	LT	--	--
Decanoic acid[1]	29	--	--
2,5-Bis(1,1-dimethylpropyl)-2,5-cyclohexadiene-1,4-dione[1]	LT	--	--
2-Ethylhexanoic acid[1]	--	31	--
Benzoic anhydride[1]	--	59	--
4-Chlorobenzoic acid[1]	--	13	--
3-Ethylpentene[1]	--	6.7	--
Methylcyclodecane[1]	--	LT	--
2-Methylundecane[1]	--	LT	--
4,11-Dimethyltetradecane[1]	--	LT	--
5-Propyltridecane[1]	--	LT	--
1-(2-Butoxyethoxy)ethanol	--	--	8.0
Compounds potentially of natural origin			
Hexanoic acid[1]	13	--	--

Table 18.--Analyses of ground-water samples from unconsolidated deposits along the Niagara River-Robert Moses Parkway, Niagara Falls, N.Y., January 13, 1983.

[Locations are shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number and depth below land surface (ft)				
	(RMP-2) 29.0	(RMP-3) 26.0	(RMP-4) 23.0	(RMP-5) 25.0	(RMP-6) 25.0
pH				6.6	7.7
Specific conductance (µmho/cm)				2,500	627
Temperature (°C)				9.3	8.0
Inorganic Constituents					
Antimony	1.3	0.7		1.0	1.3
Arsenic	1†	27†	2†	1†	1†
Beryllium	--	--	10†	--	--
Cadmium	2	2	2	2	3
Chromium	10	5	5	4	11†
Copper	7	5	1	6	71
Cyanide	130†	--	3,000†	--	--
Lead	47†	15	6	27	430†
Mercury	0.1†	0.1†	0.1†	5.9†	0.1†
Nickel	5	20	2	7	10
Selenium	1	--	1	--	--
Silver	--	--	--	--	--
Zinc	2,500	9,200†	3,600	2,400	520
Organic Compounds					
Priority pollutants					
Methylene Chloride	--	2,200,000	120,000	2,300	11
Chloroform	100	11,000†	150,000†	62	2.9
Trichlorethylene	110†	470,000†	52,000†	130†	7.2†
1,1,2,2-tetrachloroethane	39[1]	310,000	11,000	66	11
Tetrachloroethylene	6.1†	48,000†	2,000†	13†	1.7†
Benzene	--	2,000†	--	10[1]†	44†
Toluene	28	820	1,200	2.8[1]	1.1[1]
Chlorobenzene	1.2[1]	510[1]†	460[1]†	4.3	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standard for maximum concentration in ground water.

Table 18.--Analyses of ground-water samples from unconsolidated deposits along the Niagara River-Robert Moses Parkway, Niagara Falls, N.Y., January 13, 1983 (continued)

[Locations are shown in pl. 3. Concentrations are in μg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number				
	(RMP-2)	(RMP-3)	(RMP-4)	(RMP-5)	(RMP-6)
Organic compounds (continued)					
Priority pollutants (continued)					
α-BHC	0.12†	49†	--	0.68†	0.22†
β-BHC	0.68†	47†	--	0.64†	0.14†
Lindane (γ-BHC)	--	7.9†	--	0.28	--
Heptachlor	--	--	--	0.67†	--
Trans-1,2-dichloroethylene	160[1]	20,000	9,100	180	--
Ethylbenzene	--	--	--	LT	LT
1,1,2-Trichloroethane	--	270†	--	--	--
Tetrachloroethane	--	3,100†	--	--	--
1,3-Dichlorobenzene	--	LT	20	--	--
1,2-Dichlorobenzene	--	LT	14	--	--
1,4-Dichlorobenzene	--	-	13	--	--
Hexachloroethane	--	280†	--	--	--
1,2,4-Trichlorobenzene	--	72	22	--	--
Hexachlorobutadiene	--	15†	--	--	--
Naphthalene	LT	--	--	--	--
Dibutylphthalate	9.9	--	23	13	7.3
Butylbenzlphthalate	--	--	--	29	--
Bis(2-ethylhexyl) phthalate	22	--	17	--	7.1
Phenol	--	--	14†	--	--
Nonpriority pollutants					
Diethylphthalate	10	LT	10	--	8.3
Hexane[1]	170	--	3,100	22	220
Octachloropentene	--	--	LT	--	--
Dibenzoanthracene	10	--	--	--	--
Acetone(2-propanone)[1]	--	8,800	--	--	--
2,2,4-Trimethylpentane[1]	--	1,600	--	--	--
Methylcyclopentane[1]	--	--	--	LT	22
3-Methylpentane[1]	--	--	--	--	5.6
2-Methylthietane[1]	5.7	--	15	--	--
1,3-Dichlorobutane[1]	LT	--	--	--	--
1-(2-Butoxyethoxy)-ethanol[1]	LT	--	--	--	15
1,1'-Oxybis(4-chloro)-butane[1]	36	--	--	--	--
1,2,3,4,7,7-Hexachloro-bicyclo-(2.2.1)hepta-2,5-diene[1]	LT	--	--	--	--

Table 18.--Analyses of ground-water samples from unconsolidated deposits along the Niagara River-Robert Moses Parkway, Niagara Falls, N.Y., January 13, 1983 (continued)

[Locations are shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number				
	(RMP-2)	(RMP-3)	(RMP-4)	(RMP-5)	(RMP-6)
Organic compounds (continued)					
Nonpriority pollutants (continued)					
Hexanedioic acid, dioctylester[1]	LT	--	--	--	--
Pentachloroethane[1]	--	1,500	--	--	--
Pentachlorocyclopropane[1]	--	50	--	--	--
1,1,3,4-Tetrachloro-1,3-	--			--	--
butadiene[1]	--	280	--	--	--
Hexanedinitrile[1]	--	77	--	--	--
1,2,3-Trichlorobenzene[1]	--	47	--	--	--
Hexachlorobutene[1]	--	14	--	--	--
1,3,5-Trithiane[1]	--	31	26	--	--
1-Propoxybutane[1]	--	52	--	--	--
1,2,3,4,5,6-Hexachloro-				--	--
(1 alpha,2 beta,3 alpha,				--	--
4 beta,5 alpha,6 beta)-				--	--
cyclohexane[1]	--	20	--	--	--
1,2,3,4,5,6-Hexachloro-(1 alpha,2 alpha,3 beta, 4 alpha,5 alpha,6 beta)-cyclohexane[1]	--	110	--	--	--
1,2,3,4,5,6-Hexachloro-(1 alpha,2 alpha,3 beta, 4 alpha,5 beta,6 beta) cyclohexane[1]	--	35	--	--	--
1,2,3,4,5,6-Hexachloro-(1 alpha,2 alpha,3 alpha 4 beta,5alpha, 6beta)-cyclohexane[1]	--	8.5	--	--	--
2-Butoxyethylbutyl phthalate[1]	--	31	--	--	--
Dimethylsulfide	--	--	31	--	--
1-(1-Isobutyl-3-methyl-1-butenyl)pyrrolidine[1]	--	--	LT	--	--
O-Cresol[1]	--	--	LT	--	--
1,2,4-Trimethylbenzene[1]	--	--	-	LT	--
1,3,5-Trimethylbenzene[1]	--	--	-	LT	--
Compounds potentially of natural origin					
1,7,7-Trimethylbicyclo-(2.2.1)-heptan-2-one (camphor)[1]	--	--	12	--	--

Table 19.--Analyses of ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983.

[Locations shown in pl. 3. Concentrations are in μg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number and depth below land surface (ft)			
	(NFB-1) American Falls 109 ft well (48.0)	(NFB-2) American Falls 47 ft well (45.0)	(NFB-3) Robert Moses Parkway North #1 (73.7)	(NFB-4) Robert Moses Parkway North #2 (72.2)
Inorganic Constituents				
Antimony		--		
Arsenic	1†	5†	6†	7†
Beryllium	--	10†		--
Cadmium	--	66†	--	6
Chromium	--	--	--	--
Copper	12	580	26	190
Cyanide		--		
Lead	3	3,600†	24	630†
Mercury	0.3†	0.1†	6.8†	1.2†
Nickel	120	460	32	10
Selenium	1	1	--	2
Silver	2	2	4	5
Zinc	230	8,700†	250	1,200
Organic Compounds				
Priority pollutants				
Chloroform	1.7	LT	--	--
Toluene	LT	3.7	LT	--
α-BHC	--	--	--	0.2†
Heptachlor	0.04†	--	0.02†	0.03†
Endosulfan	--	--	--	0.04
Bis(2-ethylhexyl) phthalate	15	--	--	--
Di-n-octylphthalate	13	--	--	--
Trichloroethylene	6.2†	--	--	--
Tetrachloroethylene	58	6.0	1.7	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standard for maximum concentrtion in ground water.

Table 19.--Analyses of ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983 (continued)

[Locations shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number			
	(NFB-1) American Falls 109-ft well	(NFB-2) American Falls 47-ft well	(NFB-3) Robert Moses Parkway North #1	(NFB-4) Robert Moses Parkway North #2
Organic Compounds (continued)				
Nonpriority pollutants				
1,1,2-Trichloro-1,2,2-triflouroethane[1]	--	2.1	--	--
2-Methyl-1-pentene[1]	--	130	20	930
3-Methylpentane[1]	--	15	1.3	74
Hexane[1]	--	320	20	5,100
2,3-Dimethyl-2-pentene[1]	--	LT	--	--
Butane[1]	--	--	LT	--
2-Butene[1]	--	--	LT	--
2-Methylbutane[1]	--	--	LT	--

	Well number and depth below land surface (ft)			
	(NFB-5) 13th Street (22.0)	(NFB-6) 14th Street (21.0)	(NFB-7) Cudaback Avenue (20.0)	(NFB-8) Niagara Avenue (20.0)
Inorganic Constituents				
Antimony	--	--	5	1
Arsenic	2†	3†	2†	14†
Beryllium	--	--	--	--
Cadmium	20†	16†	89†	13†
Chromium	13	6	--	16
Copper	110	49	800	53
Cyanide	--	60†	--	--
Lead	570†	400†	3,500†	300†
Mercury	0.1†	0.1†	0.1†	0.1†
Nickel	130	90		130
Selenium	2	1	760†	1
Silver	2	1	1	1
Zinc	1,900	310	30,000†	1,400
Organic Compounds				
Priority pollutants				
Toluene	5.4	LT	7.8	1.6
Trichloroethylene	LT	--	33†	--
Tetrachloroethylene	--	LT†	8.8†	LT†

Table 19.--Analyses of ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983 (continued)

[Locations shown in pl. 3. Concentrations are in μg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number			
	(NFB-5) 13th Street	(NFB-6) 14th Street	(NFB-7) Cudaback Avenue	(NFB-8) Niagara Avenue
Organic Compounds (continued)				
Nonpriority pollutants				
2-Methyl-1-pentene[1]	56	7.1	6.9	--
Methylcyclopentane[1]	--	--	--	8.0
3-Methylpentane[1]	6.0	LT	--	--
Hexane[1]	160	47	20	24
Isooctane[1]	1.5	--	--	--
Trans-1,2-dichloroethylene	--	--	80	--
Trichlorofluoromethane[1]	--	--	--	4.7
1,1,2-Trichloro-1,2,2-triflouroethane[1]	--	--	--	4.4
7-Oxabicyclo[4.1.0]-heptane[1]	18	--	--	--
2,2-Dichlorobutyl-propanoate[1]	8.8	--	--	--
E-2-Hexen-1-ol[1]	--	16	--	--
1-Chloro-2-nitroso-cyclohexane[1]	--	15	--	--
Methylcyclohexane[1]	--	--	10	--
Trans-4-chlorocyclo-hexane[1]	--	--	11	--
Trans-2-chlorocyclo-hexanol[1]	--	--	--	16
2-Bromo-1-phenylethanol[1]	--	--	--	2.8
N-(Aminocarbonyl)-benzamide[1]	--	--	--	7.0

Table 19.--Analyses of ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983 (continued)

[Locations shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number and depth below land surface (ft)	
	(NFB-9) 61st Street (22.0)	(NFB-10) 60th Street (21.0)
pH		7.5
Temperature (°C)		9
Inorganic Constituents		
Antimony	--	--
Arsenic	4†	3†
Beryllium	--	--
Cadmium	30†	23†
Chromium	37	44
Copper	180	190
Cyanide	90†	360†
Lead	400†	630†
Mercury	0.1†	0.1†
Nickel	190	200
Selenium	1	1
Silver	2	1
Zinc	670	720
Organic Compounds		
Priority pollutants		
Toluene	LT	--
Bis(2-ethylhexyl)phthalate	9.4	--
Trichlorofluoromethane	15	LT
Nonpriority pollutants		
1,1,2-Trichloro-1,2,2-triflouroethane[1]	14	4.6
Hexane[1]	LT	16
Methylcyclopentane[1]	--	6.4
Trans-4-chlorocyclohexanol[1]	8.6	--
1,1'-Bicyclohexyl[1]	15	--

Table 19.--Analyses of ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983 (continued)

[Locations shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number and depth below land surface (ft)		
	Power Authority of State of New York		
	(NFB-11) PASNY #1 (37.0)	(NFB-12) PASNY #2 (37.0)	(NFB-13) PASNY#3 (36.0)
pH	7.4	8.4	8.3
Specific conductance (µmho/cm)	1,290	450	1,750
Temperature (°C)	10.4	7.9	8.4
Inorganic Constituents			
Antimony	1.0	--	1.5
Arsenic	4†	4†	3†
Beryllium	--	--	--
Cadmium	3	3	5
Chromium	20	20	12
Copper	92	63	61
Cyanide	--	--	0.04
Lead	410†	420†	390†
Mercury	0.9†	0.1†	0.2†
Nickel	43	20	16
Selenium	--	1	--
Silver	--	--	--
Zinc	3,500	710	280
Molecular sulfur (S6)	25	--	30
Molecular sulfur (S8)	1,450	--	330
Organic Compounds			
Priority pollutants			
Benzene	180†	--	250†
Toluene	34	2.2	5.7
Chlorobenzene	15	LT	35
Ethylbenzene	5.6	1.4	1.4
Hexachlorobenzene	0.47†	0.09†	--
α-BHC	0.44†	0.78†	1.4†
β-BHC	0.26†	0.25†	1.4†
Lindane	LT	LT	0.13
Heptachlor	LT†	LT†	--
1,4-Dichlorobenzene	10	--	65
1,3-Dichlorobenzene	18	--	30
1,2-Dichlorobenzene	15	--	33
Nitrobenzene	8.5	--	--
1,2,4-Trichlorobenzene	11	--	27
Naphthalene	31	--	LT

Table 19.--Analyses of ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983 (continued)

[Locations shown in pl. 3. Concentrations are in µg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number		
	Power Authority of State of New York		
	(NFB-11) PASNY #1	(NFB-12) PASNY #2	(NFB-13) PASNY #3
Organic Compounds (continued)			
Priority pollutants (continued)			
Di-n-butylphthalate	17	--	18
Butylbenzylphthalate	36	--	61
Bis(2-ethylhexl)phthalate	13	9.4	10
Trans-1,2-dichloroethylene	1,400	24	1,400
Trichloroethylene	LT[†]	26[†]	15[†]
Tetrachloroethylene	LT	8.8	3.4
Nonpriority pollutants			
Diethylphthalate	-	12	LT
Hexane[1]	64	12	20
1,1,2,2-Tetrachloroethane[1]	17	--	--
1-Chloro-2-methylbenzene[1]	71	--	14
4-Bromobutylbenzene[1]	90	--	--
1-Chloro-4-methylbenzene[1]	14	--	--
1,3,5-Trimethylbenzene[1]	150	--	--
1-Ethyl-2-methylbenzene[1]	31	--	--
1,2,3-Trimethylbenzene[1]	11	--	--
1,2,4-Trimethylbenzene[1]	84	--	--
1-Ethenyl-2-methylbenzene[1]	8.5	--	--
1,4-Diethylbenzene[1]	5.9	--	--
1-Methyl-2-propylbenzene[1]	7.2	--	--
Decylbenzene[1]	9.6	--	--
1-Methyl-3-(1-methylethyl)-benzene[1]	5.7	--	--
1,2-Diethylbenzene[1]	LT	--	--
1-Methyl-3-propylbenzene[1]	18	--	--
1-Ethyl-2,4-dimethylbenzene[1]	29	--	--
1-Methyl-2-(1-methylethyl)-benzene[1]	22	--	--
2-Methyl-2-propenylbenzene[1]	LT	--	--
1-Methyl-3-(1-methylethyl) benzene[1]	24	--	--
2-Ethyl-1,4-dimethylbenzene[1]	5.3	--	--
1-methyl-4-(1-methylethyl) benzene[1]	8.5	--	--
1,2,3,5-Tetramethylbenzene[1]	9.6	--	--

Table 19.--Analyses of ground-water samples from bedrock wells in Niagara Falls, N.Y., December 1982-January 1983 (continued)

[Locations shown in pl. 3. Concentrations are in μg/L, dashes indicate that constituents or compound was not found, LT indicates it was found but at less than the quantifiable detection limit, blanks indicate not analyzed.]

	Well number		
	Power Authority of State of New York		
	(NFB-11) PASNY #1	(NFB-12) PASNY #2	(NFB-13) PASNY #3
Organic Compounds (continued)			
Nonpriority pollutants (continued)			
1,2,3,4-Tetramethylbenzene[1]	24	--	--
1-Ethyl-2,4-dimethylbenzene[1]	28	--	--
2,3-Dihydro-1-methyl-1-H-indene[1]	6.3	--	--
1,2,3,4-Tetrahydronaphthalene[1]	2.5	--	--
1,3,5-Trichlorobenzene[1]	1.5	--	--
2-Methylnaphthalene[1]	3.7	--	--
1,1'-Biphenyl[1]	LT	--	--
1,1'Oxybisbenzene[1]	5.4	--	--
1,5-Dimethylnaphthalene[1]	LT	--	--
1,4-Dimethylnaphthalene[1]	LT	--	--
4-(1,1,3,3-Tetramethyl-butylphenol[1]	5.7	--	--
Hexathiopane[1]	LT	--	--
Unknown hydrocarbons[1]	--	19	--
2,4-Dichloro-2-Methylbenzene[1]	--	--	LT
μ-BHC	--	--	LT
N-Methyl-1H-imidazole-4-ethanamine[1]	--	--	11

Table 20.--Heavy-metal concentrations in samples obtained from undisturbed soils in Niagara Falls, N.Y., May 31, 1983 and June 1, 1983

[Locations are shown in pl. 3. Concentrations in μg/kg; dashes indicate that constituent was not found.]

Location	Sample number	Cadmium	Chromium	Copper	Lead
DeVeaux School	SB-8	--	7,000	9,000	20,000
Oakwood Cemetery	SB-9	5,000	10,000	20,000	30,000
Liberty Park	SB-10	5,000	10,000	20,000	50,000

		Mercury	Nickel	Zinc
DeVeaux School	SB-8	150	--	23,000
Oakwood Cemetery	SB-9	80	20,000	46,000
Liberty Park	SB-10	130	20,000	130,000

RESULTS OF HYDROLOGIC AND CHEMICAL EVALUATION

Results of the field investigations and literature reviews for the 138 hazardous-waste-disposal sites (plus the 26 sites not recommended for investigation by NYSDEC) are summarized in tables 21 and 22. Table 21 identifies each site as having either a major or indeterminable potential for contaminant migration on the basis of available chemical and hydrologic data; table 22 lists the sites designated as having a major potential for contaminant migration. These designations are based on the data available as of 1983 and are preliminary only. More accurate predictions as to the rate and extent of leachate migration would require additional hydrologic data to define the ground-water flow patterns within the unconsolidated deposits and the fractured bedrock below, and additional sampling to determine the type, amount, and concentration of chemicals buried at each site.

Table 21.--Potential for contaminant migration from sites studied

				Migration potential		Type of data		
Site number	Registry number	Site	Type of investigation[1]	Major	Indeterminate	Geohydrologic	Chemical	Offsite migration
BUFFALO AREA (pl. 1)								
107	915004	Allied Chemical	F	X		X	X	-
113	915007	Anaconda	F		X	-	X	-
118	915009	Bethlehem Steel	L	X		X	X	XX
120-122	915012 (a,b,c)	Buffalo Color	L	X		X	X	-
132	915024	Fedder Automotive	L		X	-	-	-
135	915029	Hanna Furnace	F		X	*	X	-
138	915034	McNaughton Brooks	F	X		-	X	XX
140	915037	Houdaille-Manzel	F		X	-	X	-
141	915040	Mobil Oil	F	X		-	X	XX
142	915041	Mollenberg-Betz	L		X	-	-	-
144	915073	Otis Elevator	F		X	-	X	-
146	915045	Pratt & Letchworth	L		X	-	X	-
147	915046	Ramco Steel	F		X	-	X	-
148	915047	Republic Steel	F		X	-	X	-
162	915054	Alltift Landfill	L	X		-	X	XX
173	915065	Empire Waste	F		X	-	X	-
180	915011	Hopkins Street	L		X	-	-	-
184	915095	Kelly Island	L		X	-	-	-
190	915781	Lehigh Valley Railroad	F		X	-	X	-
196	915026	Niagara Falls Port Authority	F		X	*	X	-
200	915085	Procknall & Katra	L		X	-	X	-
203	915052	Squaw Island	F	X		X	X	-
206	915072	Tifft Farm	L		X	-	-	-
216	915013	Erie Basin Marina	L		X	X	-	-
217	915017	Donner Hanna Coke	F		X	-	X	-
219	915030	Hartwell Street Landfill	L		X	-	X	-
220	915039	W. Seneca Transfer Station	F		X	*	X	-
241	915080	Times Beach	F	X		X	X	-
249	915120	Allied Chemical, Hurwitz-Ranne	F		X	-	X	-
†253	--	Small Boat Harbor	F	X		X	X	-
†254	--	Buffalo Harbor	F	X		X	X	-

---

[1] F field investigation
L literature review only
X information available
- no information available

† not a source of ground-water contamination but hydraulically connected to Lake Erie
* limited information
XX contaminant migration reported or observed

Table 21.--Potential for contaminant migration from sites studied (continued)

Site number	Registry number	Site	Type of investigation[1]	Migration potential		Type of data		
				Major	Indeterminate	Geohydrologic	Chemical	Offsite migration
TONAWANDA AREA (pl. 2)								
6	932044	Buffalo Pumps Division	F		X	-	X	-
24-37	932018	Occidental Chemical-Durez Div.	L	X				XX
50	932066	National Grinding Wheel	L		X	-	X	-
60	932059	Roblin Steel Company	L		X	-	*	-
67	932043	Frontier Chemical-Pendleton	F		X	*	*	-
68	932060	Gratwick Park	F	X		X	X	-
72		Holiday Park	F		X	*	X	*
93	932054	Nash Road	F		X	-	X	-
103	915001	R. P. Adams	F		X	-	X	-
105	915003-b	Allied Chemical, Tonawanda		X		-	X	XX
106	915003-c	Allied Chemical, Tonawanda			X	-	X	-
108	915055-a	Tonawanda Coke	F	X		X	X	*
109	915055-b	Tonawanda Coke	F		X	-	X	-
110	915055-c	Tonawanda Coke	F		X	-	X	-
111	915055	Aluminum Match Plate	F		X	-	*	-
114	915061	Ashland Petroleum	L		X	-	-	-
115	915008-c	Ashland Petroleum	L		X	-	*	*
116	915008-a	Ashland Petroleum	L		X	-	X	-
117	915008-b	Ashland Petroleum	L		X	-	-	-
123	915016	Columbus McKinnon	L	X		*	X	XX
125-127	915018 (a,b,c)	Dunlop Tire	F		X	-	X	-
128	--	Dupont	F		X	-	X	-
130	915023	Exolon	L		X	-	-	-
131	915025	FMC	F		X	-	X	-
136	--	INS	F	X		X	X	-
137	915035	Pennwalt-Lucidol Div.	F		X	-	X	-
143	--	O-Cel-O	L		X	-	-	-
149	915036	Roblin Steel	F		X	*	*	-
150-151	915048	Shanco Plastics	F		X	-	X	-
153-155-(a,b)	915050 (a-d)	Spaulding Fibre	F/L		X	-	X	-
158		Union Carbide	L		X	-	*	-
160	915057	J. H. Williams	F		X	-	X	-
167	915014	Chemical Leaman	F		X	*	X	-
182	915063	Huntley Power Station	F	X		X	X	-
201	915074	Seaway Industrial Park	L		X	X	X	-
204	915083	William Strassman	F		X	*	X	-
207	915079	City of Tonawanda Landfill	F		X	-	X	*
208	915078	Veteran's Park	L		X	-	*	-
211	915067	Air Force Plant no. 40	L		X	-	-	-
243	932068	Botanical Gardens	F		X	*	X	-
252	915123	Creekside Golf Course	F		X	*	X	-
NIAGARA FALLS AREA (pl. 3)								
1	932001	Airco Alloys	L		X	-	X	*
2	932002	Airco Speer Carbon-Graphite	F		X	*	X	-
4	932004	Basic Carbon Co.	F		X	-	X	-
5	932052	Bell Aerospace	F	X		-	X	XX
7	932048-a	Carborundum, Bldg. 89	L		X	-	-	-
8	932048-b	Carborundum, Bldg. 82	L		X	-	-	-
9	932007	Carborundum-Abrasive Div.	L		X	-	X	-

Table 21.--Potential for contaminant migration from sites studied (continued)

Site number	Registry number	Site	Type of investigation[1]	Migration potential		Type of data		
				Major	Indeterminate	Geohydrologic	Chemical	Offsite migration
TONAWANDA AREA (pl. 2)								
6	932044	Buffalo Pumps Division	F		X	-	X	-
24-37	932018	Occidental Chemical-Durez Div.	L	X				XX
10	932036	Carborundum-Globar Plant	L		X	-	-	-
11	932009	Chisholm Ryder	F		X	*	X	-
14	932047	Dupont, Necco Park	L	X		-	X	XX
15-19, 250	932013 (a-f)	Dupont, Buffalo Avenue	L	X		X	X	-
21	932015	Frontier Bronze	F		X	-	X	-
22	932016	Great Lakes Carbon	F		X	-	X	-
38	932020	Occidental-Love Canal	L	X		X	X	XX
39	932021	Occidental-Hyde Park	L	X		*	X	XX
40	932022	Occidental-102nd Street	L	X		X	X	XX
41a	932019-a	Occidental-S-area	L	X		-	X	XX
41b-49	932019b-c	Occidental-Buffalo Ave. Plant	L	X		-	X	XX
51	932028	TAM Ceramics	L		X	-	X	-
56	932031	Olin-102nd Street Landfill	L	X		-	X	XX
57	932050	Olin-Industrial Welding	L		X	-	*	-
58,59, 248	932051 (a,b) 932038	Olin-Buffalo Avenue	F	X		X	X	-
62	932034	Stauffer Chemical, N Love Canal	L		X	-	X	*
63	932049	Stauffer-Art Park	F		X	*	X	-
64	932035	Union Carbide	F		X	-	X	-
66	932040	Reichold-Varcum	L	X		-	X	XX
73	932067	La Salle Expressway	L		X	-	X	-
76	932006	Lynch Park	F		X	-	X	*
77	932025	Modern Disposal Service	F		X	-	X	-
78a,78b	932046, 932042	CECOS & Niagara Recycling	L		X	-	X	-
79	952091	Power Authority Road Site	L		X	-	-	-
81	932026	Niagara County Refuse Disposal	F		X	-	X	-
82	932079	Adams Generating Plant	F		X	-	*	-
83	932080	Buffalo Avenue	F	X		X	X	-
84	932008	Cayuga Island	F		X	*	X	-
85	932081	Griffon Park	F	X		X	X	-
86	932082	Hydraulic Canal	F		X	-	X	-
87	932083	New Road	F		X	-	X	-
88	932085	64th Street	F		X	-	X	-
89	932088	Whirlpool Site	F		X	-	X	-
90	932027	Witmer Road	F		X	-	X	-
91	932089	Town of Niagara Landfill, Lockport Road	L		X	-	X	-
92	932090	Niagara Falls Transportation Authority	F		X	*	X	-
94	932055	Niagara River-Belden Site	F		X	-	X	*
95	932056-a	Old Creek Bed-Dibacco	F		X	*	X	-
96	932067	Robert Moses Parkway	F/L		X	*	X	-
100	932093	Sibergeld Junk Yard	F		X	-	X	-
237	932086	Rodeway Inn	F		X	*	X	-
238	932087	St. Marys School	F		X	-	X	-
242	932063	Charles Gibson Site	L	X		X	X	-
245	932084	97th St. Methodist Church	F		X	*	X	-
247	932037	Olin Well	L		X	-	-	-
251		Solvent Chemical	L	X		-	X	XX
255	932053	Stauffer-PASNY	F		X	-	X	-

Table 22.--Sites that have a major potential for contaminant migration

Buffalo area.--19 sites were field checked and 6 evaluated through a literature review. Of these 25 sites, the 10 listed below were designated as having a major potential for contaminant migration:

107	Allied Chemical	915004
118	Bethlehem Steel Company	915009
120-122	Buffalo Color Corp.	915012a-c
138	McNaughton-Brooks, Inc.	915034
141	Mobil Oil Corporation	915040
162	Alltift	915054
203	Squaw Island	915052
241	Times Beach	915080

Tonawanda area.--29 sites were field checked and 21 evaluated through a literature review. Of these 50 sites, the 20 listed below were designated as having a major potential for chemical migration:

24-37	Occidental Chemical-Durez	932018
68	Gratwick-Riverside Park	932060
105	Allied Chemical	915003-b
108	Tonawanda Coke	915055-a
123	Columbus McKinnon Corporation	915016
136	INS Equipment Corporation	915031
182	Huntley Power Station	915063

Niagara Falls area.--31 sites were field checked and 32 evaluated through a literature review. Of these 63 sites, the 31 listed below were designated as having a major potential for contaminant migration:

5	Bell Aerospace	932052
14	Dupont, Necco Park	932047
15-19,250	Dupont, Buffalo Avenue	932013a-f
38	Occidental, Love Canal	932020
39	Occidental, Hyde Park	932021
40	Occidental, 102nd Street	932022
41	Occidental, Buffalo Avenue S-Area	932019a
41a-49	Occidental, Buffalo Avenue Plant	932019b-i
56	Olin, 102nd Street	932031
58,59,248	Olin, Buffalo Avenue Plant	932051a,b 932038
66	Reichold-Varcum	932040
81	Niagara County Refuse Disposal	932026
83	Buffalo Avenue	932080
85	Griffon Park	932081
242	Charles Gibson	932096
251	Solvent Chemical	--

GUIDELINES FOR FUTURE STUDIES

This study indicates that some hazardous-waste sites will require further investigation to determine the potential for contaminant migration. At other sites, however, either there is no evidence of hazardous materials, or the hydrogeologic character of the site does not appear to allow for contaminant migration, so the need for further investigation may not be required.

Hazardous wastes have been disposed of in five ways: (1) in permeable deposits adjacent to the Niagara River or tributaries to the river, (2) in relatively impermeable deposits more than 15 ft thick and overlying bedrock, (3) in relatively impermeable deposits that are less than 15 ft and overlying bedrock, (4) in relatively impermeable deposits originally thicker than 15 ft and overlying bedrock but where thickness has been reduced by excavation to less than 15 ft and overlying bedrock, and (5) in relatively impermeable deposits where manmade interferences have altered site characteristics and increased the potential for flow of water from the site. Where contaminants from sites have reached bedrock, their effects have become regional. Some general guidelines for studying these five types of sites and the related regional contamination problems are given below.

Site Studies

Sites in Permeable Deposits Adjacent to the River

Where wastes are buried in or on permeable fill or alluvial sand adjacent to the Niagara River or its tributaries, contaminants can move laterally toward the river. An example of a hydrologic investigation that addressed this concern is that conducted by Dames and Moore (1981) at the Bethlehem Steel site in the Buffalo area (see appendix A, site 118).

In an investigation of this type of site, the wastes produced and buried would be identified, the stratigraphy of the site documented, the quantity of ground water and the direction of flow delineated, and mean concentrations of the contaminant plume determined. Several observation wells would be installed in the unconsolidated deposits between the site and the river and on the upgradient side of the site to determine ground-water gradients and extent and depth of geologic units. Where possible, wells would penetrate to below yearly low water-table levels. Single measurements of water levels would give only instantaneous gradient; seasonal monitoring would indicate changes throughout the year. Water-level recorders on wells would allow correlation of ground-water fluctuations with storms and river stage. Pumping tests and slug tests could be used to measure the conductivity of geologic units.

If contaminants could have infiltrated to bedrock, or if the ground-water flow system in the bedrock differs from that in the unconsolidated deposits, several wells would need to be installed in the bedrock to determine direction of ground-water flow. Several wells would also be needed to delineate the extent of the plume and the average concentration of selected constituents in the plume. Sampling methods would depend on whether contaminant transport was relatively uniform, varied seasonally, or was influenced primarily by recharge, river fluctuations, or other influences. Initially, a wide range of contaminants would be tested at each well. Routine analyses could then be restricted to selected constituents, with a wider range analyzed periodically.

Sites in Relatively Impermeable Deposits More Than 15 Feet Thick

Where wastes are buried in relatively impermeable deposits such as lacustrine silt, clay, or till some distance from the Niagara River, tributaries, or manmade disturbances, the major form of contaminant transport is overland runoff or vertical movement to the underlying bedrock. An example of a hydrogeologic investigation that addressed this concern was that conducted at Occidental Chemical Durez by Recra Research Inc. (1980) in the Tonawanda area (appendix B, sites 24-37).

In an investigation of this kind of site, wastes produced and buried would be identified, runoff from the site measured or estimated, stratigraphy of the site documented, vertical ground-water gradients and direction of flow delineated, and mean concentrations of contaminants in ground water and in overland runoff determined. One or more wells would be installed in bedrock below the disposal area to test for contaminants.

Test drilling would be done close to the disposal area to determine the thickness of geologic units. Nested peizometers would be placed on or close to the disposal area to define vertical and horizontal hydraulic gradient, and slug or pumping tests could be done to determine the permeability of the sediments; these data could then be used to calculate rate and quantity of ground-water discharge. Where materials are unsaturated or where wells do not produce enough water for sampling, cores and associated core water could be obtained by suction lysimeter or other means for chemical analysis. The relationship between concentrations in cores and those in core water, once established at representative sites, could subsequently be used at other sites where only soil cores are obtained for analysis.

Runoff and water quality would be monitored for those sites where overland flow is significant. In addition to routine sampling, stage-activated flow monitoring and water sampling may be required during and immediately after intense storms. Substrate samples collected from dry channel bottoms may indi cate presence of contaminants, but negative findings do not rule out the possi-bility of contaminant transport.

Sites in Relatively Impermeable Deposits Less Than 15 Feet Thick

Where wastes are buried in lacustrine silt, clay, sand, or till less than 15 ft thick, weathering and desiccation cracks may create secondary avenues for movement to underlying bedrock and significantly increase the potential for lateral movement offsite. Examples of hydrogeologic investigations that addressed this concern are those done in the Niagara Falls area at Necco Park (site 14) by Weston (1979) and at Tam Industries (site 51) by the Conestoga-Rovers and Associates (1979 Hyde Park monitoring program).

Further investigation of this type of site would entail identification of (1) wastes produced and buried, (2) runoff from the site (measured or estimated), (3) stratigraphy of the site, (4) vertical ground-water gradients and direction of flow, and (5) mean concentrations of contaminants in ground water and in overland runoff. Observation wells would be installed in the unconsolidated deposits both upgradient and downgradient of the site to determine horizontal movement of contaminants, and slug or pumping tests could determine permeability. Several wells would be installed in the bedrock to sample for contaminants.

Sites with Identifiable Bedrock Contamination

Where contamination from a site has reached the underlying bedrock in large, relatively permeable units such as Lockport Dolomite and Onondaga Limestone, the potential for contaminant migration offsite and to underlying bedrock units is increased significantly. A system of wells along lines radiating from the site may be needed to determine the extent of the contaminant plume in a multilayered bedrock such as that at the Hyde Park landfill in Niagara Falls (site 39, appendix C) by Occidental Chemical Corporation (1983).

At sites near a ground-water divide or mound, concentric sets of nested peizometers or wells with packers would be installed along vectors radiating from the site to define the contaminant plume. If ground water moves regionally in one direction, most observation wells would be installed downgradient from the site. Each major water-bearing zone should be screened or packed and sampled for contaminants. Water levels would be measured to determine hydraulic gradients, and pumping tests would determine permeability of the water-bearing units.

Sites With Manmade Interferences

Drainage ditches, french drains, unlined sewers, power lines, aqueducts, trenches, or pumping wells significantly increase the potential for lateral migration of contaminants in the unconsolidated deposits. Examples of studies at such sites include that by Recra Research, Inc. and Wehran Engineering Corporation (1979) at Seaway (site 201, Tonawanda, appendix B) and by the U.S. Environmental Protection Agency (1982) at Occidental Chemical Love Canal (site 38, Niagara Falls, appendix C).

In addition to installing wells and sampling water flowing horizontally, conduits and fill around conduits would be sampled for contaminants, particularly during storms.

Modeling of Regional Ground-Water Flow

A regional ground-water model of flow patterns in both the unconsolidated material and in the bedrock units would be needed to assess the regional effects of contaminant migration. An example of a flow model of part of a region is that developed by Bergeron (U.S. Geological Survey, written commun., 1984) for the Hyde Park Landfill (site 39) in Niagara Falls.

Because ground water moves vertically, a three-dimensional model or cross-sectional model would be required, and in some areas, multiple layers would be needed to represent the bedrock units. The modeled area should be large enough to include hydrologic boundaries (Niagara River, Lake Erie, forebay canal, underground conduits, etc.). Water-level data from wells would be needed for model calibration and verification, and, where data were inadequate, additional observation wells would need to be installed. Also, the location, type, thickness, and permeability of the geologic units would need to be determined. Maps of depth to top of bedrock, thickness of unconsolidated overburden, and maps of bedrock stratigraphy would be useful guides.

A model could provide information about (1) direction and rate of ground-water flow, (2) effects of external hydrologic fluctuations such as changes of river stage and seasonal recharge on ground-water fluctuations and boundary discharges, (3) effects of pumping on flow patterns, (4) rate of leakage to deep aquifers, (5) effects of removing or adding discharge wells, and (6) effects of proposed remedial measures. The model could also serve as a basis for solute-transport models to evaluate the effects of contaminant migration from individual sites.

SUMMARY

American and Canadian monitoring of the quality of the Niagara River has indicated a need to assess contamination entering the river through the ground-water system. The contamination probably emanates from point and nonpoint sources in the adjacent area, which contains a high density of chemical-manufacturing facilities and waste-disposal sites.

An Interagency Task Force on Hazardous Waste, composed of representatives of the New York State Department of Environmental Conservation, New York State Department of Health, and U.S. Environmental Protection Agency, identified 215 hazardous waste-disposal sites in Erie and Niagara Counties in a report issued in March 1979. Of these sites, 164 are within 3 miles of the Niagara River in Erie and Niagara Counties, N.Y. Of the 164 sites, 138 were studied as having a potential for offsite contaminant migration.

The U.S. Geological Survey reviewed records and, during the summer of 1982, obtained chemical analyses of ground-water and core samples from 79 sites. The objectives of the investigation were to (1) determine which sites are a possible source of contamination to the ground-water system, (2) classify the sites as to potential for ground-water contaminant migration, and (3) determine, where data were sufficient, the potential effects of site leachate on the quality of ground water.

The study area, a 37-mile band 3 miles wide along the Niagara River from Lake Erie to Lake Ontario, was divided into three areas--Buffalo, Tonawanda, and Niagara Falls on the basis of site density. The study entailed three phases--a general literature review, site reconnaissance and sampling, and a regional drilling and sampling program to obtain background hydrogeologic data for reference.

This report describes the methods of investigation, the field procedures, and the quality-control system for chemical sampling and analysis. It also categorizes the sites' potential for contaminant migration either as major or indeterminable from the data available. Hydrogeologic and chemical data from the individual sites are given in the appendices; the sources of data are included. For the few sites having sufficient data, the probable effects of leachate on the ground-water quality are discussed.

Records of past and current disposal practices and geohydrologic and chemical data on 85 of the 138 sites were provided by the U.S. Environmental Protection Agency (USEPA), New York State Department of Environmental Conservation (NYSDEC), the U.S. Geological Survey, consultants to the site owner, or the site operator for use in a preliminary evaluation of the sites' potential for contaminant migration. Of these 85 site records, 59 were used as complete evaluations for this study. The remaining 26 sites along with 53 other sites were drilled and sampled as described below.

Ground water, surface water, and(or) substrates were sampled on the 79 sites mentioned above. All sampling was done according to a quality-assurance/quality-control plan acceptable to the New York State Department of Environmental Conservation, the U.S. Environmental Protection Agency, and the U.S. Geological Survey.

The number of sites studied, test holes drilled, samples collected, and the chemical constituents and compounds analyzed from each area are shown in table 23. (These summary values and individual site values are also given in table 1.)

Table 23. Sampling Summary

A. Number of sites studied, wells/test holes sampled, and samples obtained from chemical analysis

Area	Sites	No. of test holes drilled	No. of existing wells sampled	Samples collected: Ground water	Samples collected: Surface water	Samples collected: Substrate
Buffalo	19	121	10	18	6	109
Tonawanda	29	129	14	35	12	129
Niagara Falls	31	118	7	16	7	112
TOTAL	79	368	31	59	25	350

B. Number of samples analyzed for chemical constituents

	Organic compounds		Inorganic constituents											
Area	GC/MS extract-ables	Volatile	As	Cd	Cr	Cu	Fe	Pb	Hg	Ni	V	Zn	CN	S
Buffalo	82	40	32	60	90	83	102	85	32	59	22	27	4	3
Tonawanda	143	57	38	54	67	38	105	56	42	43	2	16	4	0
Niagara Falls	128	34	9	15	19	27	67	13	61	9	5	13	0	0
TOTAL	352	131	79	129	176	148	274	154	135	111	29	56	8	3

In addition to the test-hole-drilling program, an electromagnetic conductivity survey was done on 21 of the 79 sites to help delineate the extent of the disposal areas.

Among the 79 sites that were drilled and sampled were three dredge-spoil-containment sites along Lake Erie in the Buffalo area, which were studied to evaluate the potential for leachate migration to the lake. They are the Times Beach containment site (site 241), the Small Boat Harbor containment site (site 253), and the Buffalo Harbor containment site (site 254).

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APPENDICES

Page

A. Buffalo Area. 91

B. Tonawanda Area. 175

C. Niagara Falls Area. 289

APPENDICES

The site descriptions herein give the location, site history, and the potential for contaminant migration as major or indeterminate; they also include geologic, hydrologic, and chemical information in the form of driller's logs, site sketches, and tables of chemical analyses. Results of the electromagnetic conductivity surveys are also included.

The tables of chemical data on samples obtained by the U.S. Geological Survey indicate which inorganic constituents or organic compounds exceeded USEPA 1980 criteria for maximum permissible concentrations in drinking water or the New York State standards for maximum concentration in ground water. Because no criteria or standards have been established for most constituents and compounds, the absence of indicators does not mean that the quality is acceptable for use. The USEPA criteria are given in table 24 with the State of New York criteria for comparison.

All analyses were done by contract laboratories through USEPA or U.S. Geological Survey except where otherwise indicated.

Table 24.--Maximum permissible concentrations of selected chemical constituents and organic compounds in surface water and ground water.

[Concentrations are in µg/L; dashes indicate no established limit, ND means none should be detected using most current methods of detection.]

			State of New York	
	U.S. Environmental Protection Agency criteria (1980)[1]	Risk factor[2]	Drinking-water standards (1982)[3]	Ground-water standards (1978)[4]
pH	--		--	6.5-8.5
Foaming agents	--		--	500
Inorganic constituents				
Antimony	146	--	--	--
Arsenic	ND	2.2×10^{-4}	50	25
Barium	--	--	1,000	1,000
Beryllium	ND	3.7×10^{-3}	--	--
Cadmium	10	--	10	10
Chloride	--	--	250,000	250,000
Chromium VI	50	--	50	50

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[1] U.S. Environmental Protection Agency, 1980, Water quality criteria pursuant to section 304 (a) (1) of the Clean Water Act: Federal Register, v. 45, no. 231, November 28, 1980, p. 79318-79379.

[2] Risk of obtaining one more case of cancer at the given concentration in a population of 1 million.

[3] New York State drinking-water regulations, 1982.

[4] Ground-water classifications, quality standards, and effluent standards: Title 6, official compilation of codes, rules and regulations, pt 703, September 1978.

Table 24.--Maximum permissible concentrations of selected chemical constituents and organic compounds in surface water and ground water (continued)

			State of New York	
	U.S. Environmental Protection Agency criteria (1980)[1]	Risk factor[2]	Drinking-water standards (1982)[3]	Ground-water standards (1978)[4]
Inorganic constituents (continued)				
Copper	1,000	--	1,000	1,000
Cyanide	52	--	--	200
Fluoride	--	--	2,000-2,200	1,500
Iron	--	--	300	300
Lead	50	--	50	25
Manganese	--	--	300	300
Mercury	1.7×10^{-3}	--	2	2
Nitrate	--	--	10,000	10,000
Selenium	260	--	10	20
Silver	50	--	50	50
Sulfate	--	--	250,000	250,000
Thallium	13	--	--	--
Zinc	5,000	--	5,000	5,000
Organic compounds				
Acenaphthene	20	--	--	--
Acrolern	320	--	--	--
Acrylonitrile	ND	5.8×10^{-2}	--	--
Alachlor	--	--	--	35
Aldicarb	--	--	--	0.35
Aldrin	ND	7.4×10^{-5}	--	ND
Atrazine	--	--	--	7.5
Azinphosmethyl	--	--	--	4.4
Benefin	--	--	--	35
Benzene	ND	6.6	--	ND
Benzidine	ND	1.2×10^{-4}	--	--
Benzo(a)pyrene	--	--	--	ND
Bis-2-chloroethylether	ND	3.0×10^{-2}	--	1
Bis-chloromethylether	ND	--	--	--
BHC's				
α-HCH	ND	9.2×10^{-3}	--	ND
β-HCH	ND	1.63×10^{-2}	--	ND
tech-HCH	ND	1.23×10^{-2}	--	ND
γ-HCH	ND	1.86×10^{-2}	--	ND
Bromacil	--	--	--	4.4
Butachlor	--	--	--	3.5
Captan	--	--	--	17.5
Carbaryl	--	--	--	28.7
Carbon chloroform exact	200	--	--	--
Carbon tetrachloride	ND	.4	--	5
Chloramben	--	--	--	87.5
Chlordane	ND	4.6×10^{-4}	--	0.1
Chloroform	--	--	--	100
DDT	ND	2.4×10^{-5}	--	ND
Diazinon	--	--	--	0.7

Table 24.--Maximum permissible concentrations of selected chemical constituents and organic compounds in surface water and ground water (continued)

	U.S. Environmental Protection Agency criteria (1980)[1]	Risk factor[2]	State of New York	
			Drinking-water standards (1982)[3]	Ground-water standards (1978)[4]
Organic compounds (continued)				
Dicamba	--	--	--	0.44
Dichlorobenzenes	400	--	--	--
Dichlorobenzidines	ND	1.03×10^{-2}	--	--
Dichloroethylene	ND	3.3×10^{-2}	--	--
Dieldrin	ND	7.1×10^{-5}	--	ND
Diphenylhydrazine	--	--	--	ND
Dithane	--	--	--	1.75
Endosulfan	74	--	--	--
Endrin	1	--	0.2	ND
Ethylbenzene	1,400	--	--	--
Ethylenethiourea	--	--	--	ND
Ferbam	--	--	--	4.18
Fluoranthene	42	--	--	--
Folpet	--	--	--	56
Halomethanes	ND	.19	--	--
Heptachlor	ND	.28	--	ND
Hexachlorobenzene	ND	7.2×10^{-4}	--	0.35
Hexachlorobutadiene	ND	.45	--	--
Hexachloroethane	ND	1.9	--	--
Hexachlorophene	--	--	--	7
Hexachloropentadiene	206	--	--	--
Isophorone	5,200	--	--	--
Kepone	--	--	--	ND
Lindane	2	--	4	--
Malathion	--	--	--	7.0
Maneb	--	--	--	1.75
Methoxychlor	100	--	100	35
Methyl methacrylate	--	--	--	700
Monochlorobenzene	488	--	--	--
Nitralin	--	--	--	35
Nitrobenzene	19,800	--	--	--
Nitrophenols				
Dinitrophenol	70	--	--	--
2,4-Dinitro-o-cresol	13.4	--	--	--
Nitrosamines				
n-nitrosodiethylamine	ND	8.0×10^{-4}	--	--
n-nitrosodimethylamine	ND	1.4×10^{-3}	--	--
n-nitrosodi-n-butylamine	ND	6.4×10^{-3}	--	--
n-nitrosodiphenylamine	ND	4.9	--	--
n-nitrosopyrrolidine	ND	1.6×10^{-2}	--	--
Paradichlorobenzene	ND	7.2×10^{-3}	--	4.7
Paraquat	--	--	--	2.98
Parathion	--	--	--	1.5
Pentachlorobenzene	74	--	--	--
Pentachloronitrobenzene	--	--	--	ND

Table 24.--Maximum permissible concentrations of selected chemical constituents and organic compounds in surface water and ground water (continued)

			State of New York	
	U.S. Environmental Protection Agency criteria (1980)[1]	Risk factor[2]	Drinking-water standards (1982)[3]	Ground-water standards (1978)[4]
Organic compounds (continued)				
Pentachlorophenol	1,010	--	--	21
Phenols	3,500	--	--	1
Phorate	--	--	--	ND
Phthalate esters				
Diethyl phthalate	350,000	--	--	--
Dimethyl phthalate	313,000	--	--	--
Di-n-butyl phthalate	34,000	--	--	770
Di-(2-ethylhexyl) phthalate	15,000	--	--	4,200
Polychlorinated biphenyls	ND	7.9×10^{-5}	--	.1
Polynuclear aromatic hydrocarbons (PAH)	ND	2.8×10^{-3}	--	--
Propachlor	--	--	--	35
Propanil	--	--	--	7
Propazine	--	--	--	16
Simazine	--	--	--	75.25
Styrene	--	--	--	931
Tetrachloroethylene	ND	.8	--	--
Thiram	--	--	--	1.75
Trifluralin	--	--	--	35
Toxaphene	--	--	5	ND
Toluene	14,300	--	--	--
Total trihalomethanes	--	--	100	--
Trichloroethylene	ND	2.7	--	--
Vinyl chloride	ND	2.0	--	5
Zineb	--	--	--	1.75
Ziram	--	--	--	4.18
1,1-Dichloroethylene	ND	3.3×10^{-2}	--	--
1,1,1,2-Tetrachloroethane	ND	.17	--	--
1,1,2-Trichlorethane	ND	.6	--	10
1,2-Dichloroethane	ND	.94	--	--
1,2-Diphenylhydrazine	ND	4.2×10^{-3}	--	--
1,2,4,5-Tetrachlorobenzen	38	--	--	--
2-methyl-4-chlorophenoxy acetic acid	--	--	-- --	.44
2,3,7,8-Tetrachloro-dibenzo-p-dioxin	ND	1.3×10^{-8}	-- --	3.5×10^{-5}
2,4-D	--	--	100	4.4
2,4-Dichlorophenol	3,090	--	--	--
2,4-Dinitrotoluene	ND	.11	--	--
2,4,5-T	--	--	--	35
2,4,5-TP (Silvex)	--	--	10	0.26
2,4,5-Trichlorophenol	2,600	--	--	--
2,4,6-Trichlorophenol	ND	1.2	--	--

APPENDIX A

BUFFALO AREA SITE DESCRIPTIONS

A total of 33 disposal sites in the Buffalo area were investigated to determine the potential of contaminant migration. Nineteen were investigated and sampled by the U.S. Geological Survey during its 1982 test-drilling and sampling program; the remaining 14 were evaluated through a literature review.

Of the 33 sites investigated, 10 were designated as having a major potential for contaminant migration; the remaining 23 were designated as having an indeterminable potential.

The following section describes the location, past and current disposal practices, and potential for contaminant migration at the 33 sites; it also includes the geologic, hydrologic, and chemical data. Site locations are shown on plate 1.

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107. ALLIED CHEMICAL (USGS reconnaissance) NYSDEC 915004

General information and contaminant-migration potential.--The Allied Chemical site is in the southern part of the city of Buffalo. The site had a sludge lagoon during 1930-70, in which an unknown quantity of spent vanadium pentoxide catalyst, sulfate sludges, sulfuric acid, nitric acid, salts, slag, and polymerized "sulphan" were deposited. Since then, the lagoon has been excavated and filled with clean fill.

The proximity of the site to the Niagara River creates a potential for seepage of contaminants to the river. The low pH of the ground water would tend to increase the mobility of heavy metals, thereby causing the site to have a major potential for contaminant migration.

Geologic information.--No geologic data were obtained. The site owners drilled three monitoring wells between the disposal site and the Buffalo River, but no drilling logs are available.

Hydrologic information.--Water levels in the three monitoring wells indicate ground water to be 14 to 15 ft below land surface. The water-table altitude is approximately that of the Niagara River.

Chemical information.--The U.S. Geological Survey collected samples from the three monitoring wells in July 1982 for chromium, copper, iron, lead, nickel, vanadium, and sulfide analysis. Results are shown in table A-1. Iron and lead concentrations exceeded USEPA criteria for drinking water and New York State ground-water standards.

Table A-1.--Analyses of ground-water samples from Allied Chemical, site 107, Buffalo, N.Y., July 19, 1982.
[Concentrations are in µg/L; dashes indicate that constituent was not detected.]

	Sample number and depth below land surface (ft)		
	1 (15.0)	2 (14.9)	3 (14.0)
pH	3.6†	3.9†	3.2†
Specific conductance (µmho/cm)	2,580	6,700	2,040
Temperature (°C)	11.0	11.0	11.0
Inorganic constituents			
Chromium	--	--	--
Copper	41	190	23
Iron	170,000†	900,000†	170,000†
Lead	370†	90†	61†
Nickel	19	900	200
Sulfide	--	--	--
Vanadium	9.0	--	30

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

113. ANACONDA COMPANY (USGS field reconnaissance) NYSDEC 915007

General information and contaminant-migration potential.--The Anaconda Company, in the northern part of the city of Buffalo, received 21,600 tons of coal ash, 27,000 tons of metal slag, and unknown amounts of refractories during 1930-70.

The clay unit underlying the site probably retards vertical migration of contaminants, but the rate of dispersion could not be determined. The borehole data indicated disturbed fill material; thus, contaminant migration could not be evaluated. Organic priority pollutants were found in two samples. The potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled four test borings on the site; locations are shown in figure A-1. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 3.5	Topsoil and debris.
	3.5 - 4.5	Clay, sand, dark green, wet.
	4.5 - 10.0	Clay, reddish, "balls."
		SAMPLE: 4.0 ft.
2	0 - 1.5	Topsoil brown, fill.
	1.5 - 3.0	Fill, fine-grained, clay, gray.
	3.0 - 4.0	Clay, blue-gray, wet.
	4.0 - 5.0	Clay, blue-gray.
	5.0 - 6.0	Clay, brown.
	6.0 - 11.5	Clay, brownish-red.
		SAMPLE: 4.0 ft.
3	0 - 0.5	Topsoil.
	0.5 - 2.0	Clay, red, cap?
	2.0 - 5.0	Fill, dark soil, gravel.
	5.0 - 6.0	Sand, gray, hard, some gravel.
	6.0 - 6.5	Blue, green material, wet.
	6.5 - 7.0	Same.
	7.0 - 8.0	Clay, green.
	8.0 - 10.0	Clay, red.
		SAMPLE: 6.0 ft.
4	0 - 1.5	Topsoil.
	1.5 - 5.0	Clay, sandy, brown.
	5.0 - 6.0	Black, organic-looking material.
	6.0 - 6.5	Clay, gray-green.
		SAMPLE: 5.5 ft.

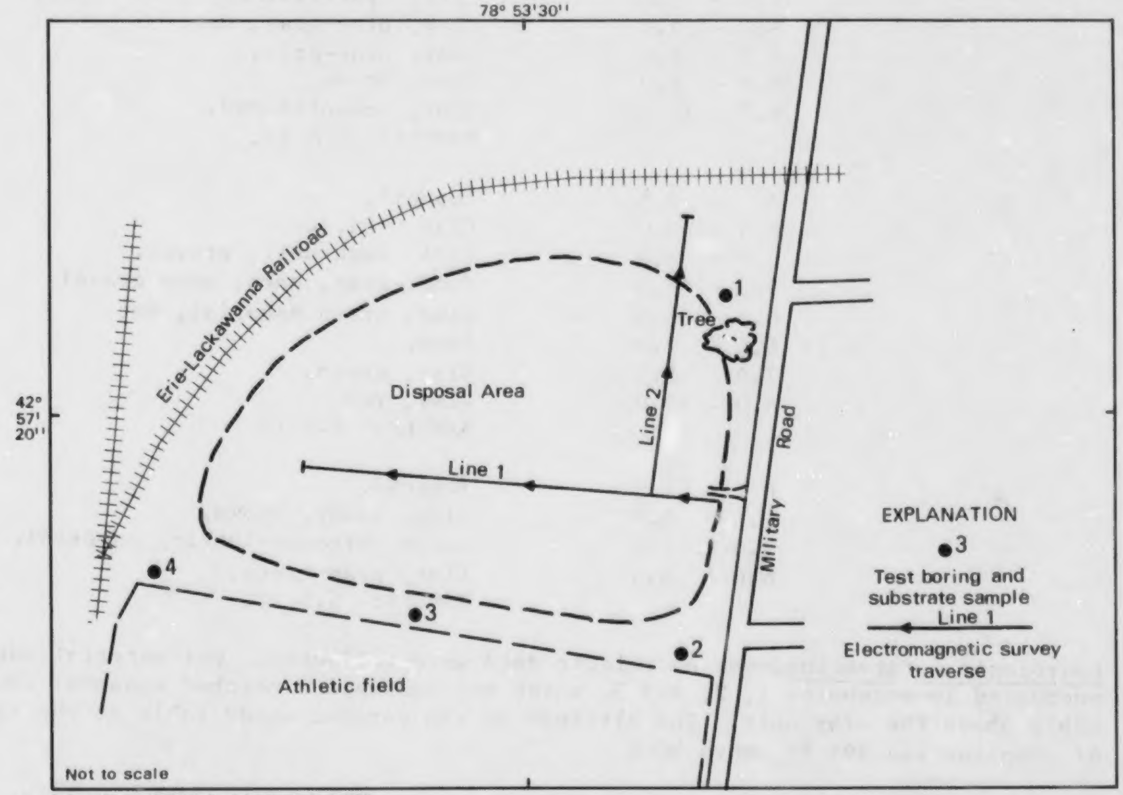
Hydrologic information.--No hydrologic data were collected. Wet material was encounted in boreholes 1, 2, and 3, which may indicate a perched seasonal water table above the clay unit. The altitude of the perched water table at the time of sampling was 595 ft above NGVD.

Chemical information.--The U.S. Geological Survey collected a soil sample at each borehole for arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, zinc, and organic-compound analysis. Results are given in A-2. Chromium, copper, and zinc exceeded the concentrations in soil samples from undisturbed areas. Samples 2 and 4 contained 13 organic priority pollutants, some in high concentrations. Four nonpriority pollutants and some unknown hydrocarbons were also detected.

Electromagnetic survey.--The U.S. Geological Survey ran an electromagnetic survey in November 1982. Two traverses were made; results are plotted in figure A-2. Several interpretations could be made from the data, as follows.

Line 1.--Except for the section between 200 and 300 ft from the origin, all of line 1 indicates subsurface waste disposal. The composition of the artificial fill (or its depth of burial), however, varies along the line. One interpretation of line 1 would be that it crosses six distinct zones of artificial fill. The first zone may be larger than the second and much broader than zones 3, 4, and 5. The horizontal extent of zone 6 cannot be determined. An alternative interpretation is that the line crosses three zones of fill and two buried metal conductors 400 and 440 ft from the origin. Other interpretations may also be possible.

Line 2.--This line also shows evidence of disturbed subsurface conditions throughout its length. Buried metallic debris is indicated at at least two locations--120 and 380 ft from the origin.



Base from USGS field sketch, 1982

Figure A-1. Location of sampling holes and electromagnetic survey lines at Anaconda Company, site 113, Buffalo.

Table A-2.--Analyses of substrate samples from Anaconda Company, site 113, Buffalo, N.Y.

[Locations shown in fig. A-1. Concentrations are in μg/kg; dashes indicate that constituent or compound was not detected, LT indicates it was detected but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
First sampling (07-28-82)	1 (4.0)	2 (4.0)	3 (6.0)	4 (5.5)
Inorganic constituents				
Arsenic	--	--	--	--
Cadmium	2,000	1,000	2,000	1,000
Chromium	8,000	10,000	5,000	240,000††
Copper	60,000††	22,000	15,000	2,000
Iron	8,600,000	8,300,000	2,300,000	12,000,000
Lead	70,000	60,000	30,000	50,000
Mercury	--	--	--	--
Nickel	10,000	10,000	10,000	20,000
Zinc	170,000††	250,000††	34,000	2,300,000††

	Sample number and depth below land surface (ft)			
Second sampling (05-29-83)	1A (4.0)	2A (4.0)	3A (6.0)	4A (5.5)
Inorganic constituents				
Molecular sulfur[1]	--	3,000	10,000	4,000
Organic compounds				
Priority pollutants				
Fluoranthene	--	4,600	--	2,600
Naphthalene	--	LT	--	LT
Benzo(a)anthracene	--	2,000	--	LT
Benzo(a)pyrene	--	1,800	--	LT
3,4-benzofluoranthene	--	2,600	--	LT
Chrysene	--	1,700	--	LT
Acenaphthylene	--	LT	--	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from undisturbed soils in the Buffalo area. Undisturbed soils were not analyzed for iron.

Table A-2.--Analyses of substrate samples from Anaconda Company, site 113, Buffalo, N.Y. (continued)

	Sample number and depth below land surface (ft)			
Second sampling (05-29-83)	1A (4.0)	2A (4.0)	3A (6.0)	4A (5.5)
Organic compounds (continued)				
Anthracene	--	LT	--	LT
Fluorene	--	LT	--	LT
Phenanthrene	--	3,900	--	5,200
Pyrene	--	4,100	--	3,400
PCB-1260	--	--	--	LT
1,2-Dichlorobenzene	--	--	--	LT
Nonpriority pollutants				
Dibenzofuran	--	LT	--	--
α-Terpene[1]	--	2,000	--	--
2-Methylnaphthalene	--	--	--	LT
Hydrocarbons[1]	--	--	--	6,000

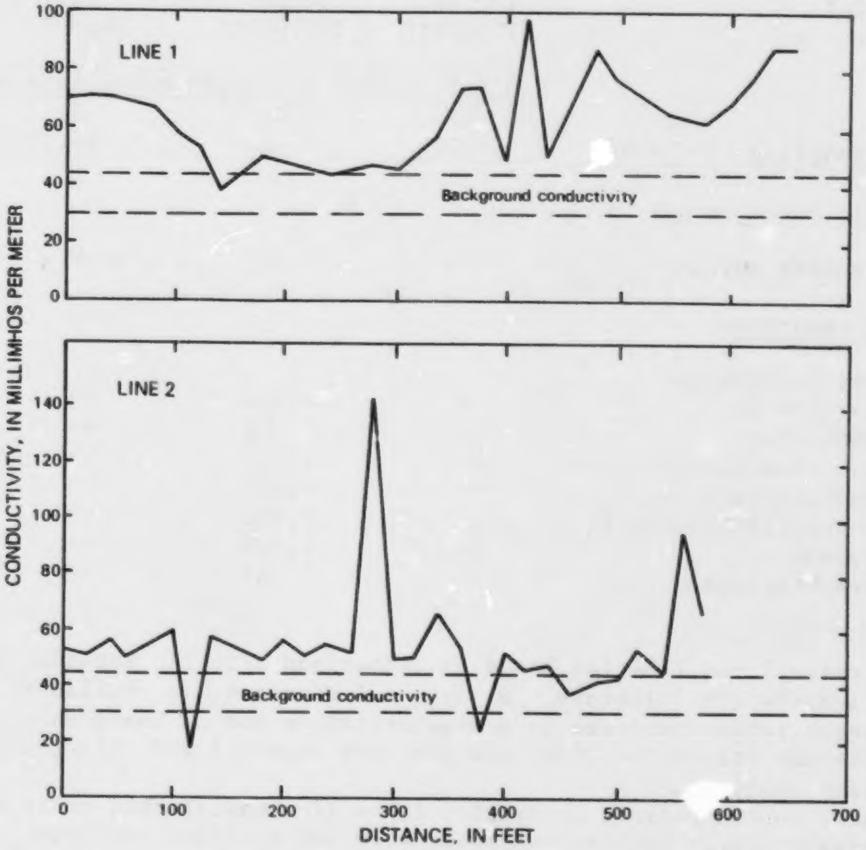


Figure A-2. Results of electromagnetic conductivity survey at Anaconda Company, site 113, Buffalo.

118. BETHLEHEM STEEL (Literature review) NYSDEC 915009

General information and contaminant-migration potential.--The Bethlehem Steel site, in Lackawanna (pl. 1), contains approximately 2,200 acres, 750 of which consist of fill adjacent to Lake Erie. The fill is mainly slag, cinders, sand, and gravel. Within this fill are wastes consisting of pickling liquor, coke-oven tar, industrial-treatment sludge, and asbestos. The location is shown in figure A-3.

A chemical-dispersion analysis was made in 1981 by the consulting firm Dames and Moore to evaluate the dilution of maximum cumulative concentration of constituents into Lake Erie. Their conclusions were as follows:

1. Analyses of lake-shore currents indicate that lake water adjacent to the landfill flows northward at approximately 1,000 ft^3/s. The discharge of ground water from the landfill is approximately 1 ft^3/s.

2. Dispersion analysis indicates that the maximum cumulative concentration of constituents at the north end of the slag waste fill area is of the same order of magnitude as the weighted average constituent discharge from the fill.

3. Dispersion analysis and results of the lake-sample analyses indicate that the 1 ft^3/s discharge of ground water from the fill area to the lake will have no significant chemical effect, provided that all other factors remain constant.

The resulting chemical concentrations in the lake are low; however, lead, phenol, chloride, sulfate, cyanide, and pH exceed New York State ground-water standards. Migration of contaminants to Lake Erie is indicated; therefore, this site has a major potential for contaminant migration to Lake Erie.

Geologic data.--Dames and Moore used several test borings to define the subsurface geology at the site. In their report (1981), they incorporated previous test-boring data with additional information obtained during the installation of monitoring wells to produce several cross-sectional diagrams of the site.

In general, the geologic sequence at the site consists of a shale or dolomitic bedrock overlain by till and (or) lake deposits of sand and silt. These units are overlain by peat, sand, gravel, and (or) fill. The fill consists of slag, cinders, sand, gravel, etc.

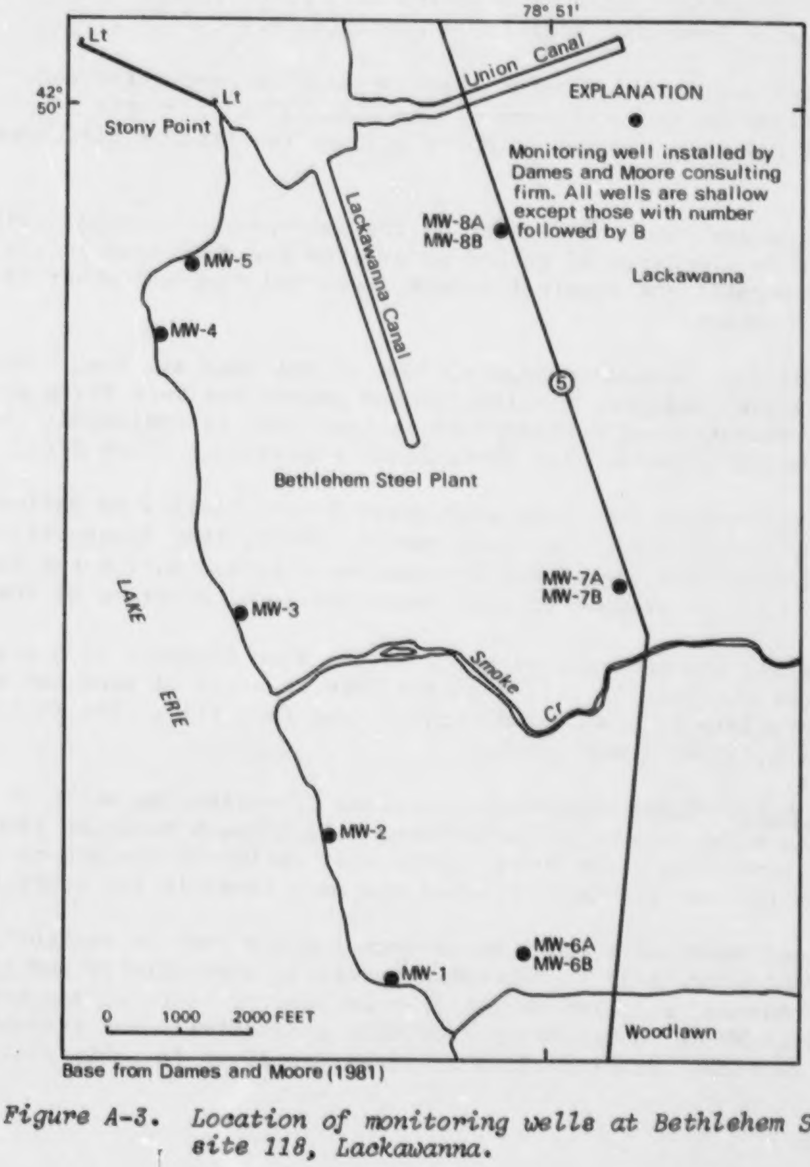
Hydrologic data.--Dames and Moore installed 11 monitoring wells at the site and measured the water levels at each during July through December 1980 (table A-3). In their report (Dames and Moore, 1981) they estimated the ground-water gradient to be 1.7×10^{-3} ft in the overburden and much lower in the upper bedrock.

Dames and Moore also ran a short-term pumping test on monitoring wells MW-1A through MW-5A (fig. A-3) to determine hydraulic conductivity and transmissivity of the overburden, and also ran short-term pumping tests on monitoring wells MW-6B through MW-8B to determine hydraulic conductivity and transmissivity of the upper bedrock. Results of these tests are given in table A-4.

Dames and Moore (1981) used the above data and Darcy's equation to calculate an approximate seepage velocity of ground water into Lake Erie. An average hydraulic conductivity of 155.8 ft/d yielded a seepage velocity of 0.88 ft/d. However, if the high hydraulic conductivity at well MW-3A is eliminated, the computed seepage velocity is 0.61 ft/d. They also calculated the total groundwater flow entering Lake Erie from the slag fill area to be 1 ft^3/s or approximately 650,000 gal/d.

Chemical data.--Dames and Moore collected several water samples from each of the 11 monitoring wells from July through December 1980. The mean concentrations of each constituent are summarized in table A-5.

Source of data.--Dames and Moore, 1981, Summary report of monitoring well program, Lackawanna Plant, Bethlehem Steel Corporation: 23 p., 12 figs.



Base from Dames and Moore (1981)

Figure A-3. Location of monitoring wells at Bethlehem Steel, site 118, Lackawanna.

Table A-3.--Water-level measurements in monitoring wells at Bethlehem Steel, site 118, Lackawanna, N.Y., July through December 1980.
[Water-level data from Dames and Moore (1981). All values are in feet above NGVD.[1] Well locations are shown in fig. A-3.]

Dates of sampling 1980	MW-1A	MW-2A	MW-3A	MW-4A	MW-5A	MW-6A	MW-6B	MW-7A	MW-7B	MW-8A	MW-8B
07/09-11	575.8	574.1	574.9	574.3	582.4	577.5	577.3	578.9	572.9	583.4	574.6
07/23-24	575.0	573.9	574.7	574.3	574.5	577.5	571.3	579.0	572.4	583.3	574.6
08/06-07	575.8	574.5	575.0	574.3	574.5	577.6	571.3	579.1	572.9	583.4	574.6
08/20-21	575.8	574.1	574.8	574.3	574.3	577.3	577.5	578.8	572.8	582.8	574.6
09/03-04	575.8	574.1	574.8	574.3	574.8	577.8	577.3	579.1	572.5	583.4	574.6
09/19	576.3	574.0	574.6	575.9	574.5	587.9	577.9	579.1	572.9	583.3	574.7
10/01	575.9	574.0	574.5	573.8	574.6	577.6	577.6	578.9	572.5	583.1	574.5
10/15	575.5	573.4	574.2	572.5	573.9	577.5	577.3	578.9	572.4	582.9	574.8

[1] Mean-surface altitude of Lake Erie 573.5 ft above NGVD

Table A-4.--Pumping-test analyses of selected wells at Bethlehem Steel, site 118, in Lackawanna, N.Y.
[Data and analyses by Dames and Moore (1981). Well locations are shown in fig. A-3. Dashes indicate that value was not determined.]

Well number[1]	Hydraulic conductivity (K) (ft/d)	Transmissivity, x 10^3 (ft^2/d)
MW-1A	84	2.52
MW-2A	74	2.59
MW-3A	344	12.04
MW-4A	101	2.52
MW-5A	176	4.40
Average	155.8	4.81
Average minus well 3A value	108.8	3.00
MW-6B	0.08	--
MW-7B	187.9	--
MW-8B	18.38	--

[1] A suffix = unconsolidated strata;
B suffix = upper part of bedrock.

Table A-5.--Analyses of ground-water samples from the Bethlehem Steel, site 118, Lackawanna, N.Y., July through December 1980.

[Data from Dames and Moore (1981). Locations are shown in fig. A-3. Concentrations are in µg/L.]

Constituent	Well number				
	MW-1A	MW-2B	MW-3A	MW-4A	MW-5A
Iron, dissolved	70	60	110	110	110
Zinc, dissolved	20	20	40	40	30
Lead, dissolved	60	60	130	210	100
Chromium, dissolved	10	10	10	20	10
Ammonia (as nitrogen)	3,800	11,900	22,200	5,500	5,100
Sulfide	39,200	160,700	34,300	5,700	3,500
Phenol	60	1,500	1,100	210	300
Chloride	111,700	444,600	1,184,000	2,512,000	167,000
Sulfate	842,000	377,000	163,000	151,000	120,000
Total dissolved solids	1,905,000	2,239,000	3,551,000	5,865,000	1,728,000
Cyanide, total	440	300	420	220	190
Oil and grease	2,000	1,900	2,900	1,100	1,030
pH	11.53	11.31	11.10	11.90	12.48
Total organic carbon	4,540	48,240	50,220	6,870	10,230
Total suspended solids	108,000	58,000	125,000	23,000	14,000

	Well number					
	MW-6A	MW-6B	MW-7A	MW-7B	MW-8A	MW-8B
Iron, dissolved	150	460	130	2,580	220	120
Zinc, dissolved	50	40	30	30	30	30
Lead, dissolved	70	60	100	70	70	70
Chromium, dissolved	10	10	10	10	10	10
Ammonia (as nitrogen)	2,100	2,400	700	1,400	1,200	1,700
Sulfide	300	200	300	500	900	200
Phenol	40	18	24	28	47	10
Chloride	51,000	87,000	74,000	137,000	150,000	107,000
Sulfate	161,000	67,000	223,000	245,000	337,000	72,000
Total dissolved solids	493,000	765,000	605,000	980,000	898,000	470,000
Cyanide, total	160	50	160	130	230	40
Oil and grease	1,230	3,150	1,290	2,670	1,510	2,160
pH	7.44	7.22	7.53	7.23	8.18	7.87
Total organic carbon	25,900	22,540	15,530	10,840	15,080	7,130
Total suspended solids	885,000	324,000	649,000	256,000	1,225,000	119,000

120-122. BUFFALO COLOR CORPORATION (Literature review) NYSDEC 915012-a,b,c.

General information and contaminant-migration potential.--The Buffalo Color Corporation sites, in the southern part of the city of Buffalo (pl. 1), consist of the following:

(120) two lagoons for iron oxide sludge that were used from 1930-63,

(121) a weathering area that may contain traces or organic compounds in dye sludge, and

(122) a 774-ft well used to dispose of 3.5 Mgal of 40-percent ammonium sulfate from 1957-63.

The limited hydrologic data suggest that the movement of ground water is relatively slow; however, the proximity of the disposal sites to the Niagara River, and concentrations of hazardous organic compounds and heavy metals greater than 10 times the levels in the samples from undisturbed areas, indicate that these sites have a major potential for contamination to the Buffalo River.

Geologic information.--The site owners installed nine piezometers on the property in 1982; the locations are shown in figure A-4. Only the drilling log of piezometer 6, shown below, was available.

Depth (ft)	Description
0-2	Mixture of purple and black cinders, slag, and foundry sand.
2-4	Fill, mostly clay with cinders, slag and foundry sand. Clay varied in color with red and brown.
4-6	Fill, mostly brown clay, with some pockets of slag and cinders. Cinders and foundry sand in lower 6 inches.
6-8	Fill, brown clay with black, clayey layer 6 inches at bottom. Slight odor.
8-10	Mixed brown clay, slag, cinders.
10-12	Wet black cinders, foundry sand and slag. Slight odor.
12-14	Wet black cinders, slag, foundry sand.
14-16	Brown sandy silt with thin clay laminations. Mottling of sample from brown to gray brown. Slight odor.
16-18	Gray-brown sandy silt with some organic (woody) material interbedded. Slight odor.
18-20	Dark brown sandy silt with organic (woody) plug at base. Slight odor.

Hydrologic information.--Daily water-level measurements were taken at eight of the nine piezometers during June 1-24, 1982. The average water level in each piezometer during this period is listed below; the water-table contours from these levels are shown in figure A-4.

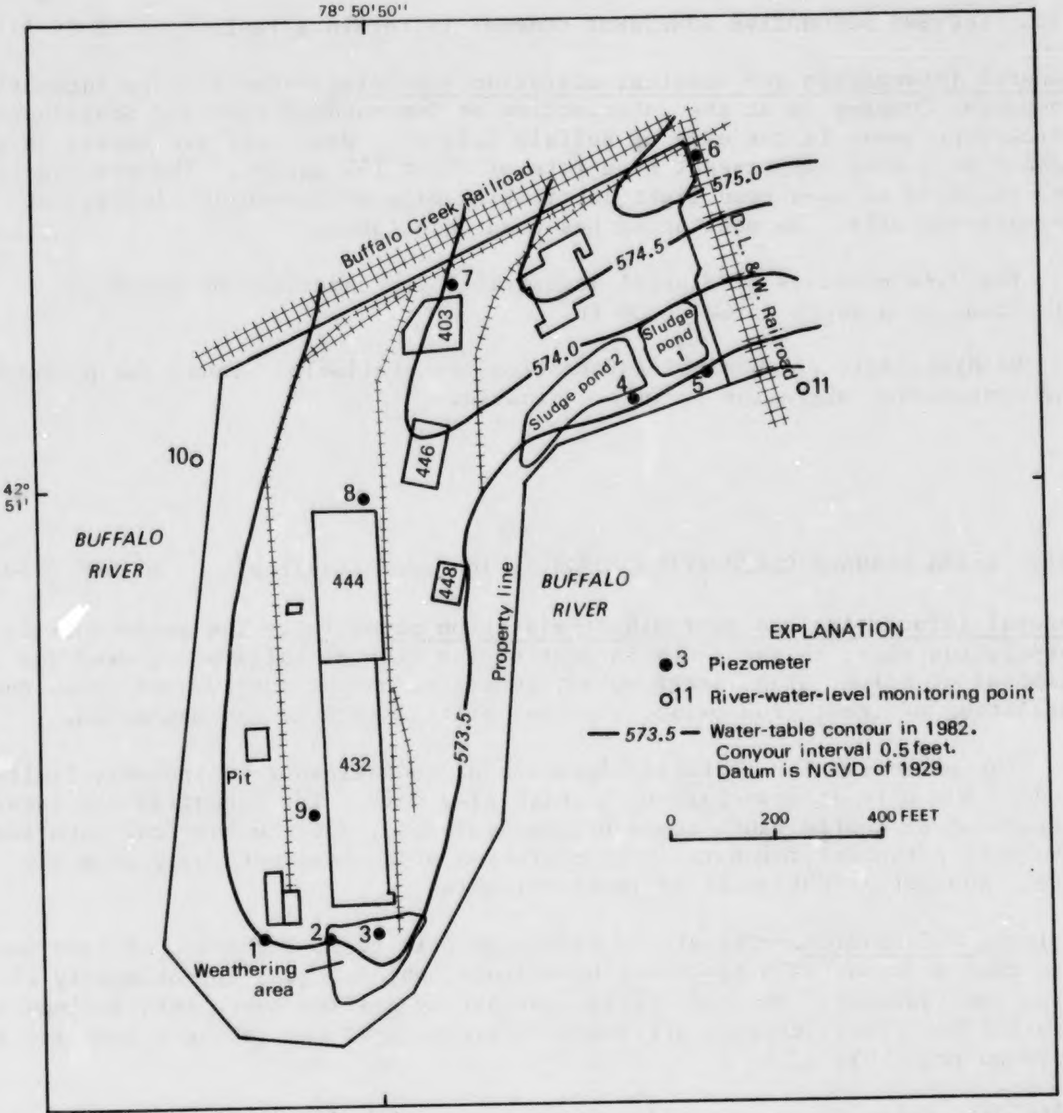
Piezometer number	Average daily water level (ft above NGVD)	Piezometer number	Average daily water level (ft above NGVD)
1	573.5	7	574.0
2	573.5	8	- -
3	573.6	9	573.8
4	573.7	10	[1]573.2
5	573.5	11	[1]573.1
6	575.3		

[1] Buffalo River stage

The hydraulic conductivity (K) of the overburden at the site has been calculated to be approximately 0.01 m/d (0.0328 ft/d) (Holzmacher, McLendon and Murrel, written commun. to NYSDEC, 1982). This value, combined with the gradient data from figure A-4, yields a rate of ground-water movement of 0.024 ft/yr in the weathering area and of 0.06 ft/yr in the sludge-pond areas. These values are only approximations; additional data would be needed to verify them.

Chemical information.--No ground-water chemical data are available. However, two composite soil samples collected in December 1982 by the site owner indicated the following constituents and compounds in the weathered area at the levels shown below. (NYSDEC, written commun., 1983):

	Concentration (µg/kg)	
Priority pollutants	maximum	mean
Arsenic	1,870	989
Chromium, total	1,050	904
Copper	6,200	5,905
Lead	57,600	41,900
Mercury	138	89
Nickel	103	82
Zinc	2,130	1,462
Benzidine	1.0	1.0
Acenaphthene	1.0	1.0
Naphthalene	2.0	1.5
Fluorene	1.9	1.5
Anthracene, Phenanthrene	9.6	5.2
Fluoranthene	10	6
Pyrene	6.7	3.8
Chrysene, Benzo(a)anthracene	4.6	2.8
Benzo(b)fluoranthene, benzo fluoranthene, benzo(a)pyrene	7.9	4.8
Dinitrotoluene	1,000	500
Nonpriority pollutants		
Chromium, hexavalent	3.2	1.9
1-Naphthylamine	0.2	0.2



Base from Holzmacher, McLendon, and Murrell (written communication to NYSDEC)

Figure A-4. Water-table altitude and location of sampling holes at Buffalo Color Corporation, sites 120-122, Buffalo.

132. FEDDERS AUTOMOTIVE COMPONENT COMPANY (Literature review) NYSDEC 915024

General information and chemical-migration potential.--The Fedders Automotive Component Company is at the intersection of Tonawanda Street and Scajaquada Creek Expressway in the city of Buffalo (pl. 1). Waste oil was spread on the ground as a dust suppressant at a rate of about 165 gal/yr. The waste oils are reported to have been light lubricating oils or hydraulic fluids, not transformer oils. No monitoring has been undertaken.

The site consists of glacial lacustrine clay underlain by Onondaga Limestone at a depth of 40 to 60 ft.

No hydrologic or chemical information are available. Thus, the potential for contaminant migration is indeterminable.

135. HANNA FURNACE CORPORATION (USGS field reconnaissance) NYSDEC 915029

General information and contaminant-migration potential.--The Hanna Furnace Corporation site, in the southern part of the city of Buffalo, is used for the disposal of brick, slag, scrap metal, concrete, earth, rubble, and "flue dust" consisting of iron, iron oxide, alumina, silica, carbon, and magnesium.

The potential for vertical migration of contaminants is probably limited because the site is underlain by a thick clay unit. The potential for lateral dispersion of contaminants could not be evaluated, but the chemical data indicate some potential for horizontal migration of contaminants away from the site. The actual potential is indeterminable.

Geologic information.--The site consists of fill overlying units of sand and clay that are underlain by limestone bedrock, which begins approximately 25 ft below land surface. The U.S. Geological Survey drilled seven test borings in August 1982. The locations are shown in figure A-5; the geologic logs are as shown on page 105.

Hydrologic information.--Ground water was encountered at a depth of approximately 5 ft. Land-surface altitude is estimated to be 580 ft above NGVD; thus the water-table altitude was 575 ft above NGVD.

Chemical information.--The U.S. Geological Survey collected a soil sample from each test boring for chromium, copper, iron, and lead analyses; results are given in table A-6. The results indicate that the sample from borehole 1 may have been collected on the disposal site and therefore is not indicative of contaminant migration. No other samples except sample 2, which had an elevated copper concentration, exceeded the concentrations in samples from undisturbed areas.

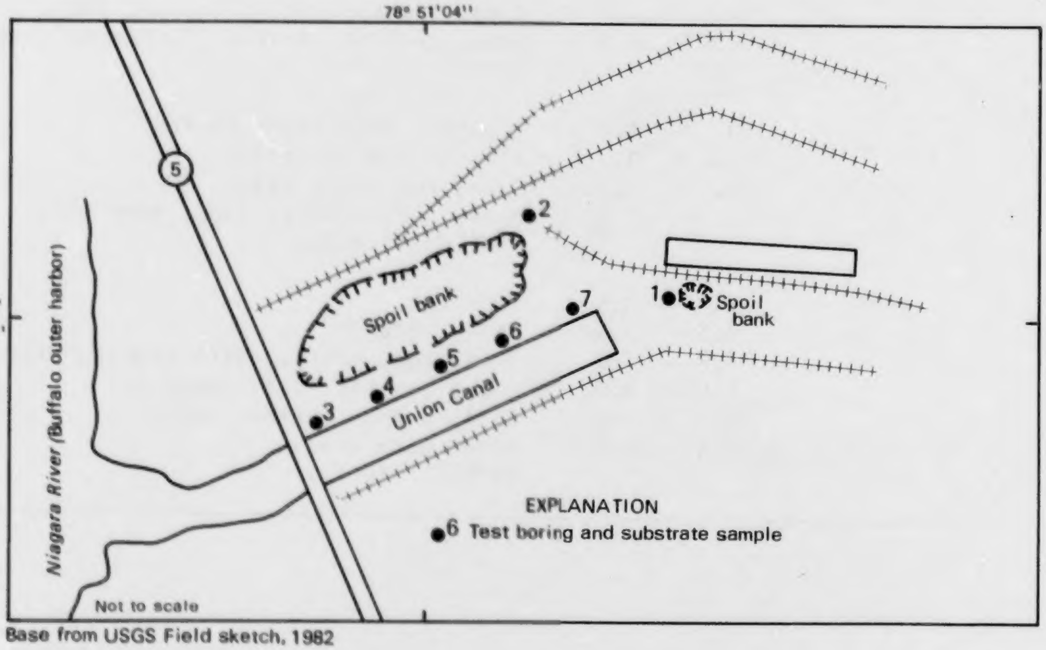
Boring no.	Depth	Description
1	0 - 2.5	Topsoil and fill.
	2.5 - 4.0	Fill material, black, organic smell.
	4.0 - 15.0	Clay, light green, tight, dry.
		SAMPLE: 2.5 ft.
2	0 - 1.0	Topsoil and fill.
	1.0 - 2.0	Rust-colored debris and gravel.
	2.0 - 3.5	Gravel roadbed fill with coarse sand.
	3.5 - 5.5	Sand, coarse, dark, wet.
	5.5 - 6.5	Clay, greenish.
		SAMPLE: 3.5 ft.
3	0 - 2	Topsoil and "coal dust", dark brown to black.
	2 - 12	Sand, black, coarse, wet 5 ft.
	12 - 15	Clay, olive, tight, dry.
		SAMPLE: 6.5 ft.
4	0 - 1.0	Topsoil, red.
	1.0 - 3.5	Sand, light gray, coarse.
	3.5 - 4.0	Pea rock, light green-blue.
	4.0 - 6.0	Sand, reddish, coarse, with clay, wet.
		SAMPLE: 5.5 ft.
5	0 - 3.0	Topsoil, dark brown to dark red.
	3 - 4.0	Sand, reddish, coarse.
	4.0 - 4.5	Sand, light-colored, coarse, damp.
	4.5 - 6.0	Sand, reddish, coarse, "iron ore", damp.
		SAMPLE: 6 ft.
6	0 - 1.0	Topsoil, dark brown to red.
	1.0 - 3.0	Black, fine material.
	3.0 - 3.5	Same, but light gray.
	3.5 - 5.5	Sand, red, coarse, damp, some clay.
		SAMPLE: 5.5 ft.
7	0 - 0.5	Topsoil.
	0.5 - 1.5	Clay, red.
	1.5 - 4.0	Sand, red, coarse, with gravel, damp.
	4.0 - 6.0	Looks exactly like "Sakrete."
	6.0 - 6.5	Sand, black, coarse, wet.
	6.5 - 10.5	Same, with slag.
		SAMPLE: 10 ft.

Table A-6.--Analyses of substrate samples from Hanna Furnace, site 135, Buffalo, N.Y., August 2, 1982.
[Locations shown in fig. A-5. Concentrations are in µg/kg.]

Constituents	Sample number and depth below land surface (ft)				
	1 (2.5)	(Split)	2 (3.5)	3 (6.5)	4 (5.5)
Chromium	400,000††	(380,000††)	7,000	6,000	3,000
Copper	170,000††	(160,000††)	92,000††	4,000	11,000
Iron	83,000,000	(71,000,000)	21,000,000	8,700,000	3,700,000
Lead	40,000	(70,000)	60,000	10,000	20,000

Constituents	Sample number and depth below land surface (ft)		
	5 (6)	6 (5.5)	7 (10)
Chromium	4,000	10,000	3,000
Copper	11,000	28,000	12,000
Iron	4,200,000	6,000,000	5,000,000
Lead	30,000	30,000	10,000

†† Exceeds concentrations in samples from undisturbed soils in the Buffalo area. Undisturbed soils were not analyzed for iron.



Base from USGS Field sketch, 1982

Figure A-5. Location of sampling holes at Hanna Furnace Corporation, site 135, Buffalo.

138. MCNAUGHTON-BROOKS, INC. (USGS field reconnaissance) NYSDEC 915034

General information and contaminant-migration potential.--The McNaughton-Brooks, Inc. site, in the city of Buffalo, contains a rubble pile upon which approximately 600 gallons of solvents such as xylol, toluol, and paint sludges were disposed of in the 1960's. This activity ceased in 1966.

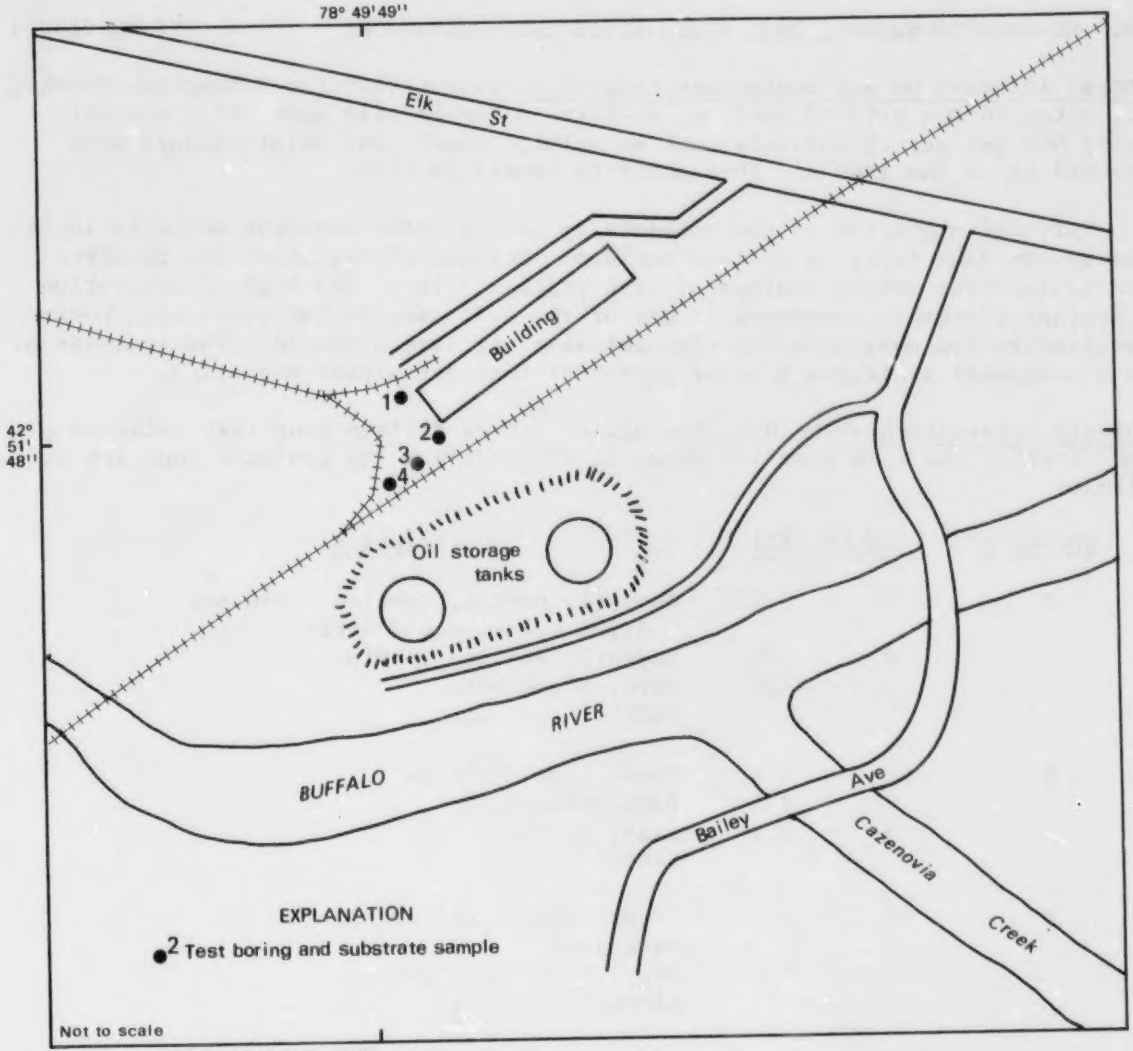
Vertical migration of contaminants by ground-water movement would be inhibited by the clay layer below land surface. Horizontal migration due to advection could occur during seasons of high precipitation. The high concentration of synthetic organic compounds in one of the soil samples indicates that horizontal migration away from the disposal site may have occurred. The presence of these compounds indicates a major potential for contaminant migration.

Geologic information.--The U.S. Geological Survey drilled four test holes on the site in 1982; the locations are shown in figure A-6. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 3.5	Topsoil, debris, rubble, could not drill there, moved 5 ft.
	0 - 2.5	Topsoil, debris, rubble.
	2.5 - 3.0	Sand, black wet. SAMPLE: 2.5 ft.
2	0 - 4	Topsoil and debris.
	4 - 6	Dark gray.
	6 - 6.5	Clay, green. SAMPLE: 5 ft.
3	0 - 2	Brown topsoil and debris.
	2 - 3	Dark gray.
	3 - 5	Clay, light gray/green. SAMPLE: 2.5 ft.
4	0 - 2	Black organic topsoil.
	2 - 4	Clay, gray/green. SAMPLE: 3 ft.

Hydrologic information.--No hydrologic data were obtained because water did not collect in the wells installed in test holes, even though the material appeared to be wet below about 2.5 ft. The moist material was encountered at approximately 580 ft above NGVD.

Chemical information.--The U.S. Geological Survey collected a soil sample at each borehole for cadmium, chromium, iron, lead, and organic-compounds analyses; results are given in table A-7. The lead concentrations were higher here than in the soil samples from undisturbed areas. The samples contained 21 organic priority pollutants, 22 nonpriority pollutants, and some unknown hydrocarbons.



Base from USGS field sketch, 1982

Figure A-6. Location of sampling holes at McNaughton-Brooks, Inc., site 138, Buffalo.

Table A-7.--Analyses of substrate samples from McNaughton Brooks, site 138, Buffalo, N.Y.

[Locations shown in fig. A-6. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
First sampling (08-05-82)	1 (2.5)	2 (5.0)	3 (2.5)	4 (3.0)
Inorganic constituents				
Cadmium	1,000	1,000	1,000	--
Chromium	6,000	7,000	4,000	5,000
Iron	7,500,000	7,100,000	2,900,000	5,700,000
Lead	520,000††	40,000	70,000	70,000

	Sample number and depth below land surface (ft)			
Second sampling (05-17-83)	1A (2.5)	2A (5.0)	3A (2.5)	4A (3.0)
Inorganic constituents				
Molecular sulfur[1]	--	--	37,000	--
Organic compounds				
Priority pollutants				
Benzene	6.8**	30.1	33.5	15.6
Ethylbenzene	70.2**	119	84.5	4.3
Methylene chloride	284 **	--	--	--
Toluene	18.0**	91.5	--	--
Phenol	--	--	--	*
Acenaphthene	*	--	*	--
Fluoranthene	*	*	*	*
Naphthalene	*	*	*	--
Bis(2-ethylhexyl) phthalate	--	--	--	*

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from undisturbed soils in the Buffalo area. Undisturbed soils were not analyzed for iron.

* Compounds detected but not quantified--Holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

** Surrogate recoveries were outside the acceptance limits.

Table A-7.--Analyses of substrate samples from McNaughton Brooks, site 138, Buffalo, N.Y. (continued)

[Locations shown in fig. A-6. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface			
Second sampling (05-17-83)	1A (2.5)	2A (5.0)	3A (2.5)	4A (3.0)
Organic compounds (continued)				
Priority pollutants (continued)				
Di-n-butyl/phthalate	*	--	--	*
Di-n-octyl/phthalate	--	--	--	*
Benzo(a)anthracene	*	*	*	--
Benzo(a)pyrene	*	*	*	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	*	*	*
Chrysene	*	*	*	*
Acenaphthylene	*	--	--	--
Benzo(ghi)perylene	*	--	*	--
Fluorene	*	--	*	--
Dibenzo(a,h)anthracene	*	--	--	--
Indeno(1,2,3-cd)pyrene	*	--	*	*
Pyrene	*	*	*	*
Nonpriority pollutants				
Acetone	257	540	--	--
2-Butanone	--	99.5	--	--
Carbon disulfide	7.9	--	--	--
4-Methyl-2-pentanone	208	--	--	--
Styrene	--	15.5	--	--
O-xylene	609	265	614	13.1
Dibenzofuran	*	*	*	*
2-Methylnaphthalene	*	-	*	*
1,7,7-Trimethyl-tricyclo-(2.2.1.02,6)heptane[1]	*	--	--	--
1-Ethyl-2-methyl-benzene[1]	*	--	--	--
Tetrahydrofuran[1]	--	*	*	*
3-Methyl-2-butanone[1]	--	*	--	--
1-Pentanol[1]	--	*	--	--
2,6,6-Trimethyl-bicyclo-(3.1.1)hepten-2-ene[1]	--	*	--	*
1,3-and 1,4-Dimethylbenzene[1]	--	*	*	--
Benzofuran[1]	--	*	*	--
Unknown hydrocarbons[1]	*	--	*	*
Cis-1,2-Dimethylcyclohexane[1]	--	--	*	--
5-Methyl-1-phenyl-hexane[1]	--	--	*	--
2-Propyloxybenzene[1]	--	--	--	*
1,3,5-Trimethylbenzene[1]	--	--	--	*
1,2,3-Trimethylbenzene[1]	--	--	--	*

NYSDEC 915037

140. HOUDAILLE INDUSTRIES--MANZEL DIVISION (USGS field reconnaissance)

General information and contaminant-migration potential.--The Houdaille Industries-Manzel Division site, in the southern part of the city of Buffalo, was used for cutting oils, solvents, and cooling compounds, which were dumped directly upon the ground.

The potential for horizontal migration of contaminants at this site is indeterminable, but the potential for vertical migration is limited by the underlying clay unit. The U.S. Geological Survey first sampled this site in 1982 but resampled it in the spring of 1983 to verify offsite contaminant migration.

Geologic information.--The site is underlain by glacial-lake deposits of interbedded clay, silt, and fine sand; these in turn are underlain by limestone bedrock at 20 ft below land surface.

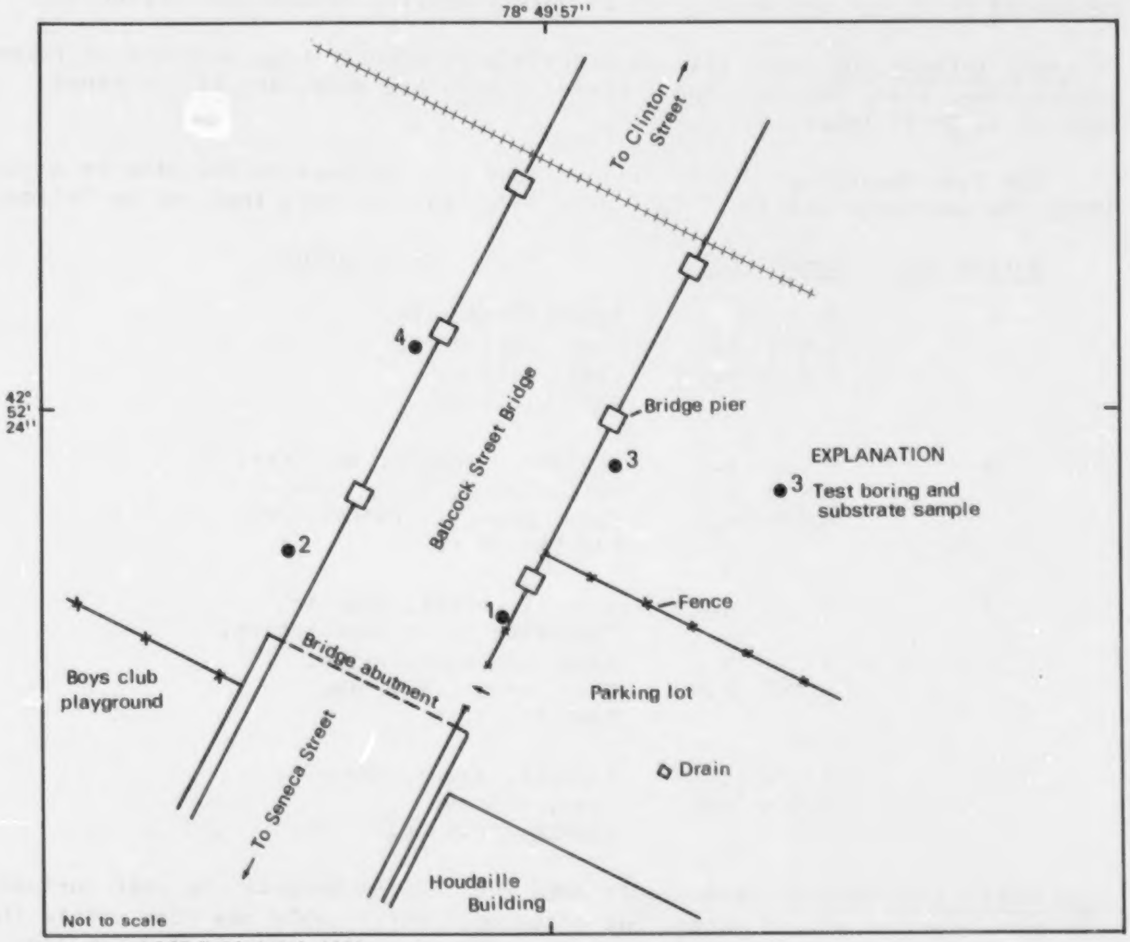
The U.S. Geological Survey drilled four test borings on the site in August 1982; the locations are shown in figure A-7. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 4.0	Topsoil and fill.
	4.0 - 4.5	Clay, dark gray.
	4.5 - 6.5	Clay, yellow.
		SAMPLE: 4 ft.
2	0 - 1.5	Topsoil, organic, peatlike.
	1.5 - 3.0	Soil, loose, brown, dry.
	3.0 - 6.5	Clay, greenish-yellow, dry.
		SAMPLE: 3 ft.
3	0 - 3.0	Topsoil, black, organic, becoming brown near bottom.
	3 - 3.5	Sand, greenish-yellow.
	3.5 - 6.6	Clay, greenish-yellow.
		SAMPLE: 3 ft.
4	0 - 2.5	Topsoil, black, organic.
	2.5 - 4.0	Clay, yellow.
		SAMPLE: 2.5 ft.

Hydrologic information.--Hydrologic data are lacking because the test borings did not encounter ground water, but a seasonal water table may form within the more permeable sand zones above bedrock. The direction of ground-water flow would most likely be southward toward the Buffalo River.

Chemical information.--In August 1981, the Erie County Department of Environment and Planning collected seven soil samples for benzene, toluene, xylene, chloroform, and polychlorinated biphenyl analysis. Toluene and xylene had concentrations of less than 7,000 μg/kg in all samples. Benzene had a concentration of less than 7,000 μg/kg in six samples, but the seventh had a concentration of 56,000 μg/kg. Chloroform concentrations ranged from 253,000 to 425,500 ppb, and polychlorinated biphenyls ranged from 310 to 38,100 ppb.

In August 1982, the U.S. Geological Survey collected four soil samples for copper, iron, lead, nickel, and organic compound analysis; results are given in table A-8. Copper in sample 3 exceeded concentrations in soil samples from undisturbed areas. The samples contained 22 organic priority pollutants, some with concentrations as high as 30,000 µg/kg (fluoranthene); six organic nonpriority pollutants were also detected.



Base from USGS field sketch, 1982

Figure A-7. Location of sampling holes at Houdaille Industries-Manzel Division, site 140, Buffalo.

Table A-8.--Analyses of substrate samples from Houdaille Industries, site 140, Buffalo, N.Y.
[Locations shown in fig. A-7. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
First sampling (08-06-82)	1 (4.0)	2 (3.0)	3 (3.0)	4 (2.5)
Inorganic Constituents				
Copper	2,000	--	100,000††	--
Iron	620,000	67,000	1,600,000	1,800,000
Lead	--	--	10,000	20,000
Nickel	--	--	--	--

	Sample number (depths are same as in first sampling)			
Second sampling (05-20-83)	1A	2A	3A	4A
Organic Compounds				
Priority pollutants				
Methylene chloride	380	--	--	210
Tetrachloroethene	560	--	--	--
Toluene	10	29	24	20
Trichloroethene	LT	--	--	--
Acenaphthene	--	--	--	1,400
Fluoranthene	30,000	650	2,300	9,500
Naphthalene	4,000	370	1,400	2,400
Di-n-butyl phthalate	6,000	--	--	--
Benzo(a)anthracene	14,000	370	1,900	3,300
Benzo(a)pyrene	18,000	280	2,800	1,900
Chrysene	10,000	370	1,900	3,300
Acenaphthalene	16,000	LT	--	4,300
Anthracene	4,000	LT	LT	2,400
Benzo(ghi)perylene	18,000	LT	2,800	LT
Fluorene	--	--	--	1,900
Phenanthrene	12,000	750	1,900	10,000
Indeno(1,2,3-cd)pyrene	16,000	LT	2,800	1,400
Pyrene	28,000	560	LT	6,200
δ-BHC	--	LT	--	--
Benzo(b)fluoranthene	--	--	3,300	2,400
Benzo(k)fluoranthene	--	--	3,300	2,400

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from undisturbed soils in the Buffalo area. Undisturbed soils were not analyzed for iron.

Table A-8.--Analyses of substrate samples from Houdaille Industries, site 140, Buffalo, N.Y. (continued)
[Locations shown in fig. A-7. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number			
Second sampling (05-20-83)	1A (4.0)	2A (3.0)	3A (3.0)	4A (2.5)
Nonpriority pollutants				
Acetone	190	--	--	--
Dibenzofuran	--	170	LT	1,900
Fluorotrichloromethane	50	18	16	46
2-Methylnaphthalene	--	280	LT	LT
1-Methylnaphthalene[1]	--	350,000	--	--
1,8-Dimethylnaphthalene[1]	--	325,000	--	--
Benzo(j)fluoranthene[1]	--	--	700,000	1,000,000

141. MOBIL OIL CORPORATION (USGS field reconnaissance) NYSDEC 915040

General information and contaminant-migration potential.--The Mobil Oil Corporation site, in the southern part of the city of Buffalo, was used to dispose of unknown quantities of cooling water, air-flotation unit sediments, gravity-separator sediments, tetraethyl lead, lubricating sludges, spent catalysts, and soil contaminated with asphalt.

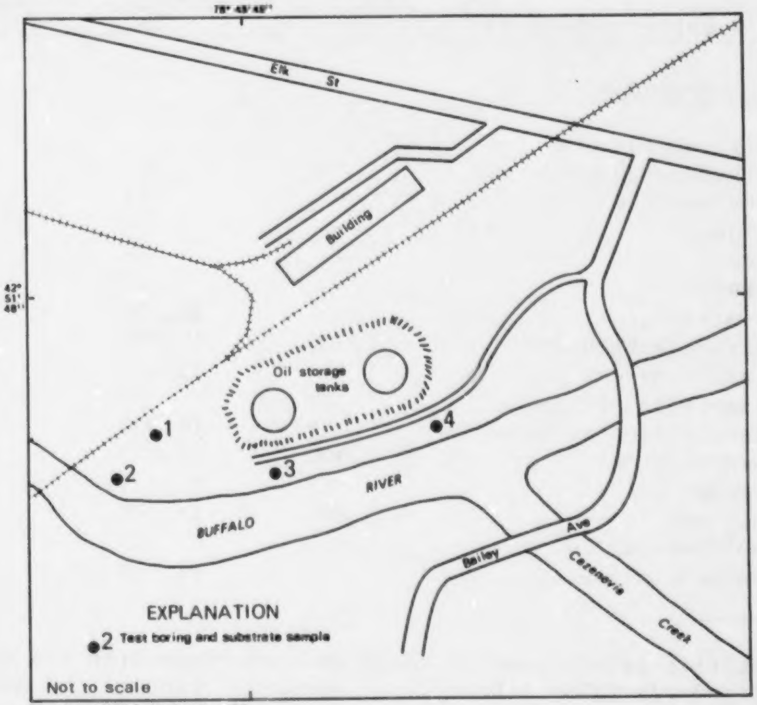
The highly permeable sand underlying the site suggests a major potential for contaminant migration to the Buffalo River. The rate of movement and the concentration of contaminants would depend on the amount of precipitation percolating through the unsaturated zone and the ground-water gradients at the site.

Geologic information.--The site consists of fill underlain by fine to medium sand and gravel. The U.S. Geological Survey drilled four test borings in August 1982; locations are shown in figure A-8. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 6.5	Topsoil, fill, gravel, sand, fine to medium, brown, wet at 5.5 ft.
	6.5 - 11.5	Same but wetter.
	11.5 - 16.5	Sand, dark gray-green; depth is below river bed. SAMPLE: 8 ft.

Boring no.	Depth (ft)	Description
2	0 - 1.0	Topsoil, brown.
	1.0 - 1.5	Clay, greenish, with petroleum smell.
	1.5 - 5.5	Sand, brown to dark brown, fill material.
	5.5 - 6.0	Black, tar-looking material.
	6.0 - 11.5	Same as above but not as wet. Still strong petroleum smell.
	11.5 - 16.5	No return, bit looked same as above.
		SAMPLE: 6 ft.
3	0 - 11.5	Fill, gravel, sand, fine to medium.
		SAMPLE: 9 ft.
4	0 - 1.5	Topsoil.
	1.5 - 5.0	Sand, medium to coarse, brown.
	5.0 - 10.0	Sand, clayey, medium to coarse, gray-brown.
	10.0 - 11.5	Clay, sandy.
		SAMPLE: 6.5 ft.

Hydrologic information.--Ground water is at or slightly above the water-surface altitude of the Buffalo River. Direction of ground-water flow is toward the river.



Base from USGS field sketch, 1982

Figure A-8. Location of sampling holes at Mobil Oil Corporation, site 141, Buffalo.

Chemical information.--The U.S. Geological Survey collected a soil sample from each test boring for lead, iron, and organic compound analysis; results are given in table A-9. One substrate sample had a much greater concentration of lead (920,000 μg/kg) than samples from undisturbed areas. Samples contained 19 organic priority pollutants, some with concentrations as high as 46,000 μg/kg; and nine organic nonpriority pollutants.

Table A-9.--Analyses of substrate samples from Mobil Oil, site 141, Buffalo, N.Y. [Locations shown in fig. A-8. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
First sampling (08-06-82)	1 (8.0)	2 (6.0)	3 (9.0)	4 (6.5)
Inorganic constituents				
Iron	150,000	110,000	3,500,000	72,000
Lead	--	30,000	920,000††	--
	Sample number (depth is same as in first sampling)			
Second sampling (05-20-83)	1A	2A	3A	4A
Organic compounds				
Priority pollutants				
Methylene chloride	790	300	--	--
Ethylbenzene	--	95	--	--
Toluene	--	13	--	11
Aldrin	--	--	--	LT
α-BHC	--	LT	--	--
Fluoranthene	1,500	38,000	--	1,100
Benzo(a)anthracene	1,000	15,000	--	520
Benzo(a)pyrene	1,000	15,000	--	520
Benzo(b)fluoranthene	LT	LT	--	--
Benzo(k)fluoranthene	LT	15,000	--	--
Phenanthrene	1,000	46,000	--	730
Pyrene	LT	31,000	--	930
Chrysene	1,000	15,000	--	730
Naphthalene	--	LT	--	--
Acenaphthalene	--	15,000	--	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from undisturbed soils in the Buffalo area. Analyses for iron were not done for the undisturbed soils.

Table A-9.--Analyses of substrate samples from Mobil Oil, site 141, Buffalo, N.Y. (continued)
[Locations shown in fig. A-8. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.)

	Sample number and depth below land surface (ft)			
Second sampling (05-20-83)	1A (8.0)	2A (6.0)	3A (9.0)	4A (6.5)
Organic compounds (continued)				
Priority pollutants (continued)				
Anthracene	--	11,000	--	--
Benzo(ghi)perylene	--	LT	--	--
Fluorene	--	11,000	--	--
Nonpriority pollutants				
Fluorotrichloromethane	--	47	--	--
2-Methylnaphthalene	--	LT	--	--
Carbon disulfide	--	LT	--	--
2-Methylbutane[1]	--	45,000	--	--
Cyclohexane[1]	--	100,000	--	--
Benzo(k)fluoranthene	--	--	--	600,000
Methylcyclohexane[1]	--	550,000	--	--
1,2-Dimethyl-cis-cyclohexane[1]	-	360,000	--	--
3-Hepten-2-one[1]	--	80,000	--	--
1-Methylpyrene[1]	--	--	--	600,000
Hydrocarbons[1]	--	870,000	--	--

142. MOLLENBERG-BETZ CORPORATION (Literature review) NYSDEC 915041

General information and contaminant-migration potential.--The Mollenberg-Betz Corporation site, in the downtown area of the city of Buffalo, is used primarily for the servicing and manufacturing of commercial refrigeration equipment. Before August 31, 1978, machinery brought into the plant was reportedly steam cleaned in a 20- by 20-ft area behind the main building before being serviced. The washwater contained oil, grease, and dirt and was permitted to percolate directly into the ground. Also reported was the use of waste oil on the parking lot for dust control. These practices ceased as of September 1, 1978.

The company's present disposal practices make contaminant migration unlikely, but the potential for contamination from this site is indeterminable.

Geologic information.--Soils in the area consist of lake silt, sand, and clay overlying dolomitic bedrock. Depth to bedrock is estimated to be approximately 20 ft below land surface.

Hydrologic information.--No ground-water data are available. Surface drainage from the site probably flows into the Buffalo sewer system.

Chemical information.--No chemical data are available.

144. OTIS ELEVATOR (USGS field reconnaissance) NYSDEC 915073

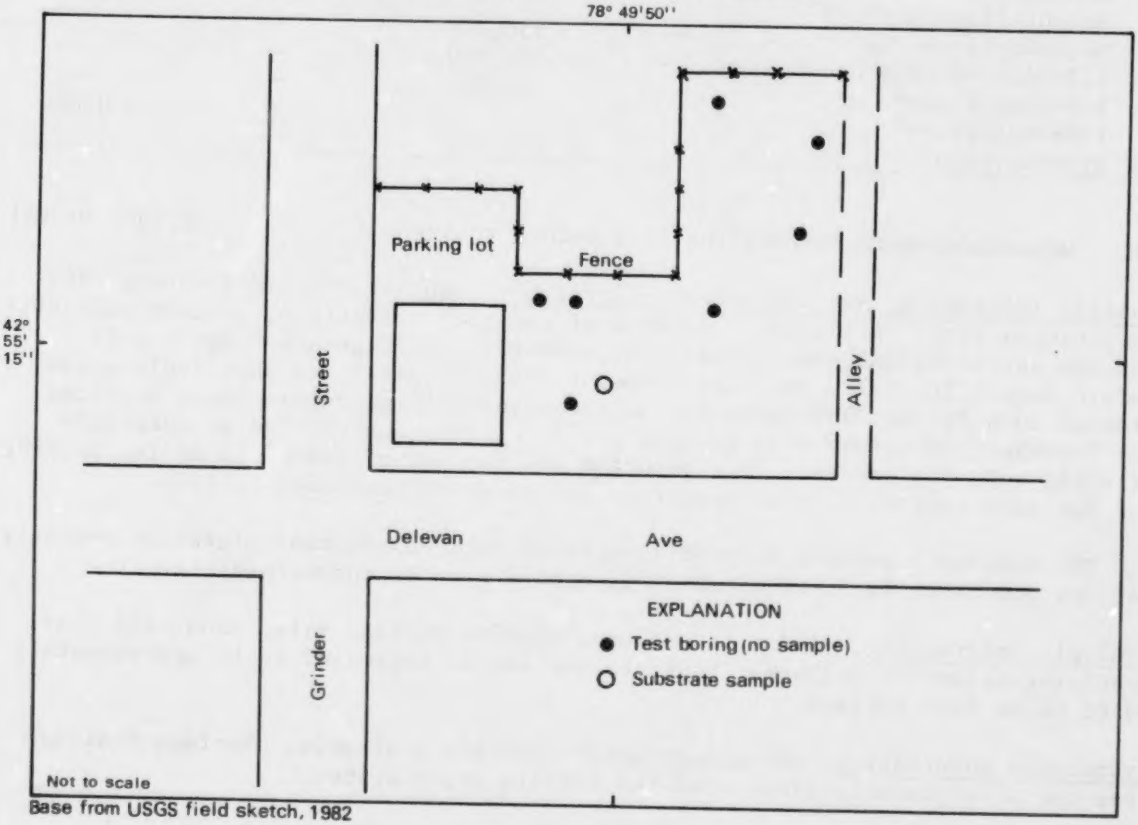
General information and contaminant-migration potential.--The Otis Elevator site, in the eastern part of the city of Buffalo, was used to dispose of an unknown quantity of foundry sand containing phenol binders until 1942. Since then, the site has been covered with soil, graded, and planted.

Data are insufficient to confirm contamination or contaminant migration. The potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled eight test borings on the site; the locations are shown in figure A-9. Seven of the borings hit refusal at 3 ft below grade, which was attributed to the rocky fill. The eighth was drilled to 4 ft below grade, and a split-spoon sample was taken. The core was described as soil with rock fragments.

Hydrologic information.--No hydrologic data were collected at the site because all test-bore cuttings were dry.

Chemical information.--The U.S. Geological Survey collected the soil sample on August 30, 1982, for phenolic compound analysis; no phenols were detected. The Survey collected another substrate sample on June 8, 1983, for organic priority pollutant analysis; no compounds were detected.



Base from USGS field sketch, 1982

Figure A-9. Location of sampling holes at Otis Elevator, site 144, Buffalo.

146. PRATT AND LETCHWORTH (Literature review) NYSDEC 915045

General information and contaminant-migration potential.--The Pratt and Letchworth site, in the northern part of the City of Buffalo, was used during 1949-65 to dispose of foundry sands, slag, lubricating and hydraulic oil, paper, and wood. The quantities of these materials were: sand, 1,200 tons/yr; slag, 1,000 tons/yr; and lubricating and hydraulic oil, 14,000 gal/yr.

Available chemical data indicate some potential for migration of constituents through the fill and into the clay unit, but more data would be needed to substantiate this and to evaluate horizontal movement. Thus, the potential for migration is indeterminable.

Geologic information.--In August 1982, the site owners drilled one geologic test boring onsite; the log indicated 15 to 18 ft of foundry sand underlain by clay.

Hydrologic information.--No hydrologic data are available because the core was dry. Any ground-water flow that may occur would probably be southeastward toward Scajaquada Creek.

Chemical information.--In August 1982, the site owners collected three soil samples of the following types: (1) foundry sand from the surface of the fill, (2) foundry sand from just above the clay, and (3) the clay soil.

The samples were analyzed for arsenic, cadmium, chromium, iron, nickel, and PCB's. In November 1982, the site owners collected three samples of the above type for phenol and total organic halogen analyses; they also collected soil samples upstream, adjacent to, and downstream of the site for the constituents listed above. Results of the analyses are given in table A-10.

Table A-10.--Analyses of soil samples from Pratt and Letchworth, site 146, Buffalo, N.Y., 1982[1]
[Concentrations are in µg/kg; blanks indicate not analyzed.]

	Sample description					
Constituent	Foundry sand at surface	Foundry sand above clay	Clay soil	Upstream soil	Adjacent soil	Downstream soil
Arsenic	<30	<30	<30	<400	<300	<300
Cadmium	<10	<60	50	1,120	1,870	1,500
Chromium	<50	<650	1,500	27,100	26,700	36,700
Iron	<250	2,500	5,600	10,700,000	18,300,000	8,532,000
Nickel	<25	300	1,000	12,800	20,200	18,000
Phenols	560	340	310	--	--	--
Total organic halogens plus PCB	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000

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[1] Analyses by Pratt and Letchworth, 1982.

147. RAMCO STEEL (USGS field reconnaissance) NYSDEC 915046

General information and contaminant-migration potential.--The Ramco Steel site is in the city of Buffalo. A detailed map showing the location of the site and of soil and surface-water-sampling points is shown in figure A-10. For an unknown period of time, a lagoon at the site received a mixture of used pickling liquors, rinse water, lime sludge, iron, and chrome. The quantity of each waste disposed of was as follows:

waste liquor	75,000 gal/yr
rinse water and lime sludge	6,000 gal/yr
iron	unknown
chrome	unknown

Use of the lagoon for waste disposal has been discontinued.

The potential for the migration of contaminants offsite is indeterminable. The slightly elevated concentrations of copper and lead indicate that some migration may be taking place, but if the underlying clay is continuous throughout the area, the potential of vertical migration would be limited. The pond-water quality should be studied in detail because the pond is a route of contaminant egress from the site.

Geologic information.--The U.S. Geological Survey drilled three test borings on the site in 1982; the locations are shown in figure A-10. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 4.0	Topsoil, black, gravel.
	4.0 - 7.0	Cinders and soil, black, very wet.
	7.0 - 10.0	Clay, sandy, brown-green, soupy, hit refusal at 10 ft. SOIL SAMPLE: 7-9 ft.
2	0 - 2.5	Rock fill.
	2.5 - 4.0	Sand, fine, brown, soupy.
	4.0 - 5.5	Clay, brown-red. SOIL SAMPLE: 4 ft.
3	0 - 2.5	Rock fill, cinders.
	2.5 - 4.0	Rock fill, very wet.
	4.0 - 5.5	Clay, sandy, olive green, wet. SOIL SAMPLE: 5 ft.

Hydrologic information.--No hydrologic data were obtained from the site because a well could not be developed to produce significant water, even though the soil was moist below 2.5 ft. Probably a seasonal water table had formed at an altitude of 580 ft above NGVD at the time of sampling.

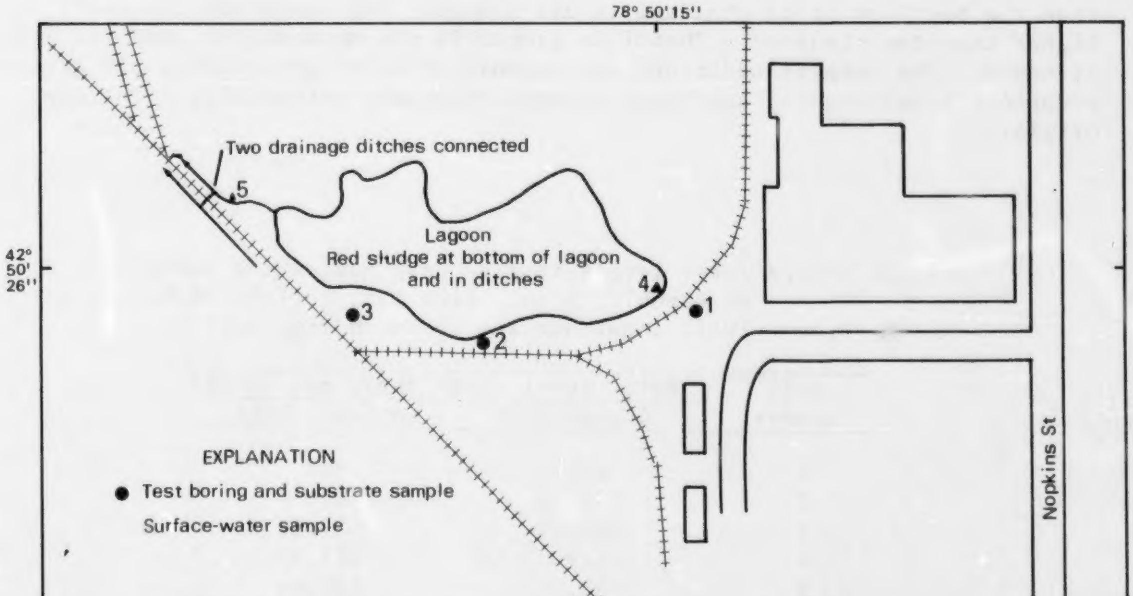
Chemical information.--The Geological Survey collected a soil sample from each of the three boreholes, a duplicate soil sample at borehole 1, and two surface-water samples from holes 4 and 5; results are given in table A-11. The substrate samples contained higher copper concentrations than soil samples from the undisturbed areas. The concentrations of iron and lead exceeded USEPA criteria for drinking water.

Table A-11.--Analyses of substrate and surface-water samples from Ramco Steel, site 147, Buffalo, N.Y., July 22, 1982.
[Locations shown in fig. A-10. Concentrations are in μg/kg and μg/L; dashes indicate that constituent or compound was not found. Blank space indicates not measured.]

	Substrate sample number and depth below land surface (ft)				Surface-water sample number	
	1 (7.0)	(Split)	2 (4.0)	3 (5.0)	4	5
Specific conductance (μmho/cm)					720	3,980
Temperature (°C)					23.0	24.0
Inorganic Constituents						
Chromium	10,000	(10,000)	--	3,000	1	--
Copper	21,000	(9,000)	6,000	53,000††	19	24
Iron	6,500,000	(7,600,000)	6,500,000	9,360,000	7,400†	17,000†
Lead	30,000	(40,000)	--	--	6	270†

† Exceeds USEPA criterion for maximum permissible concentration in drinking water.

†† Exceeds concentrations in samples taken from undisturbed soils in the Buffalo area. Undisturbed soils were not analyzed for iron.


78° 50'15''
42° 50' 26''
Two drainage ditches connected
5
Lagoon
Red sludge at bottom of lagoon and in ditches
4
1
3
2
Nopkins St
EXPLANATION
● Test boring and substrate sample
Surface-water sample
Not to scale

Base from USGS field sketch, 1982

Figure A-10. Location of sampling holes at Ramco Steel, site 147, Buffalo.

148. REPUBLIC STEEL (USGS field reconnaissance) NYSDEC 915047

General information and contaminant-migration potential.--The Republic Steel landfill, in the southern part of the city of Buffalo, has been used since 1930 for disposal and storage of precipitator dust, clarifier sludge, railroad ties, checker bricks, scrap wood, roll scale, blast-furnace dust, BOF brick, refuse, and miscellaneous debris.

Geologic and preliminary chemical data collected by the U.S. Geological Survey indicate a limited potential for contaminant migration. One water sample indicates contamination by ethylbenzene and phenol. The potential for contaminant migration is indeterminable.

Geologic information.--The site is underlain by a layer of lacustrine sediments ranging in thickness from 8 to more than 20 ft overlying a dense silty till that overlies shale bedrock.

Hydrologic information.--Water levels in five deep monitoring wells during August 1979 and February 1982 are shown in table A-12. The potentiometric surface at those times is depicted in figure A-11; both maps show the general direction of ground-water flow to be westward toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected six ground-water samples from two shallow wells and from four deep wells on the site and a surface-water sample from a drainage ditch. All ground-water samples were analyzed for USEPA priority pollutants; results are given in table A-13. Concentrations of iron in the samples were higher than the USEPA criterion for drinking water or the New York State standard for ground water. Lead was higher than the New York State standard in all samples, and manganese in sample 3A was higher than the standard. Phenol in sample 2A was much higher than the State standard. The samples contained two organic priority pollutants, six organic nonpriority pollutants, and three organic compounds potentially of natural origin.

Table A-12.--Water levels in five deep monitoring wells on Republic Steel, site 148, Buffalo, N.Y.[1]
[Well locations are shown in fig. A-11.]

Well number	Water level (feet above sea level)	
	August 1979	February 1982
1	dry	dry
2	579.56	dry
3	580.49	581.57
4	dry	579.93
5	583.10	582.86

[1] August 1979 data from McPhee, Smith, Rosenstein Engineers, P.C. February 1982 data from Malcolm Pirnie Associates.

Table A-13.--Analyses of ground-water and surface-water samples from Republic Steel, site 148, Buffalo, N.Y., July 22-23, 1982.
[Locations shown in fig. A-11. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	Surface water	Ground water		
	1	2 (24.8)	2A (4.3)	3A (14.9)
pH	7.8	9.2	11.4	8.0
Specific conductance (umho/cm)	1,430	608	2,125	900
Temperature (°C)	27.0	10.2	17.0	10.5
Inorganic constituents				
Aluminum	--	357	662	--
Antimony	--	--	--	--
Arsenic	--	--	14†	--
Barium	224	--	--	532
Beryllium	--	--	--	--
Cadmium	--	--	--	--
Chromium	30	17	37	46
Cobalt	--	--	--	--
Copper	--	--	--	--
Iron	373†	1,080†	829†	2,220†
Lead	53†	51†	36†	40†
Manganese	24	90	72	1,000†
Mercury	--	--	--	--
Nickel	--	--	--	--
Selenium	--	--	--	--
Silver	--	--	--	--
Tin	--	--	--	--
Tellurium	--	--	--	--
Vanadium	--	--	--	--
Zinc	--	26	18	46
Organic compounds				
Priority pollutants				
Ethylbenzene**	--	--	LT	--
Phenol	--	--	40†	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or the NYS standard for maximum concentration in ground water.

** Volatile found in GC/MS extractions. Concentration probably higher than that detected.

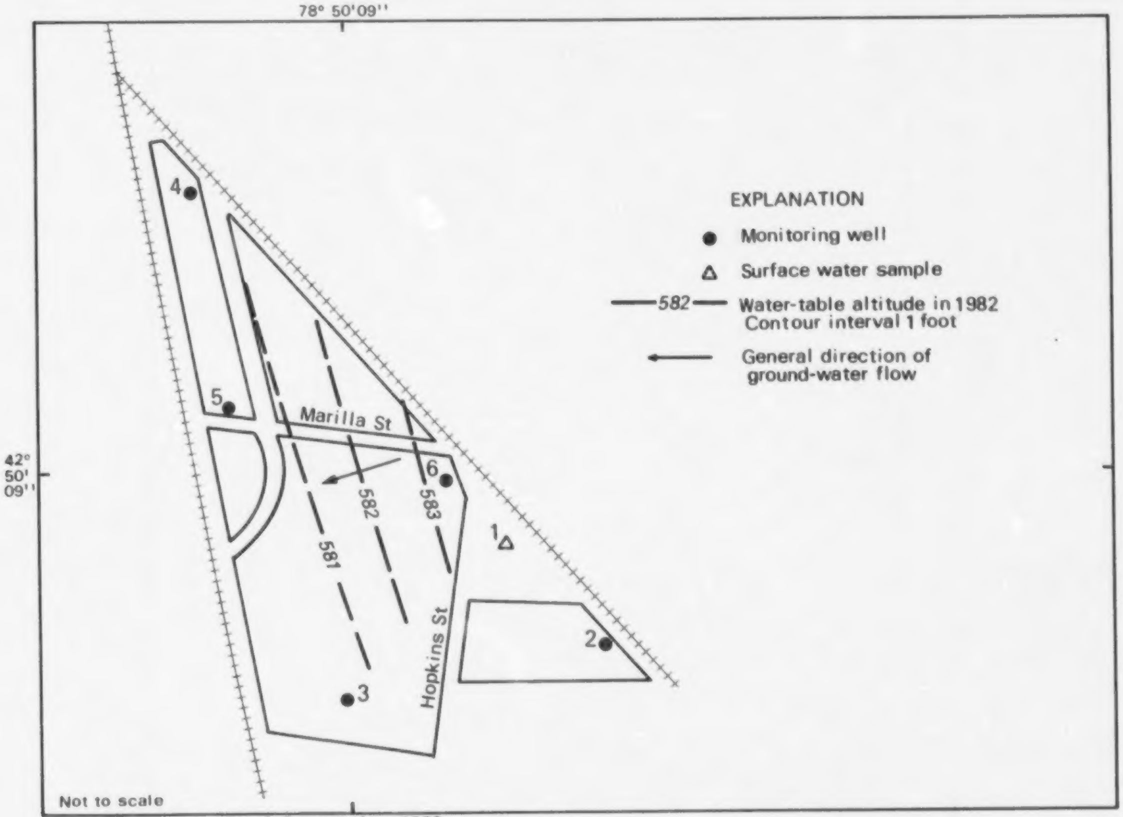
Table A-13.--Analyses of ground-water and surface-water samples from Republic Steel, site 148, Buffalo N.Y., July 22-23, 1982 (continued) [Locations shown in fig. A-11. Concentrations are in μg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	Surface water	Ground water		
	1	2 (24.8)	2A (4.3)	3A (14.9)
Organic compounds (continued)				
Nonpriority pollutants				
2,3-Dichloro-2-methyl butane[1]	LT	14	--	--
1,3-Dimethylbenzene[1]	--	24	--	20
3-Hexanol[1]	--	24	--	--
4-Methyl-2-pentanol[1]	--	13	--	--
1-(2-butoxyethoxy)-ethanol[1]	52	370	--	650

	Ground water		
	4 (19.7)	5 (17.7)	5A (4.6)
pH	11.2	7.5	7
Specific conductance (umho/cm)	710	1,025	3,625
Temperature (°C)	10.0	10.5	14.5
Inorganic constituents			
Aluminum	--	--	--
Antimony	--	--	--
Arsenic	--	--	--
Barium	158	--	--
Beryllium	--	--	--
Cadmium	--	--	4
Chromium	39	52	37
Cobalt	--	--	--
Copper	--	--	--
Iron	264	276,000†	23,400†
Lead	20	17	19
Manganese	26	574†	8,520†
Mercury	--	--	--
Nickel	--	--	--
Selenium	--	--	--
Silver	--	--	--
Tin	--	--	--
Tullerium	--	--	--
Vanadium	--	--	--
Zinc	--	17	33

Table A-13.--Analyses of ground-water and surface-water samples from Republic Steel, site 148, Buffalo N.Y., July 22-23, 1982 (continued) [Locations shown in fig. A-11. Concentrations are in μg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
	Ground water		
	4 (19.7)	5 (17.7)	5A (4.6)
Organic compounds			
Nonpriority pollutants			
1,3-Dimethylbenzene[1]	--	5.6	--
Cyclohexanol[1]	16	LT	--
Hexahydro-2H-azepho-2-one[1]	25	--	--
1-(2-butoxyethoxy)-ethanol[1]	--	150	--
Cyclohexanone[1]	78	--	--
2-Hexanone[1]	--	LT	--



Base from Republic Steel Corporation, 1982

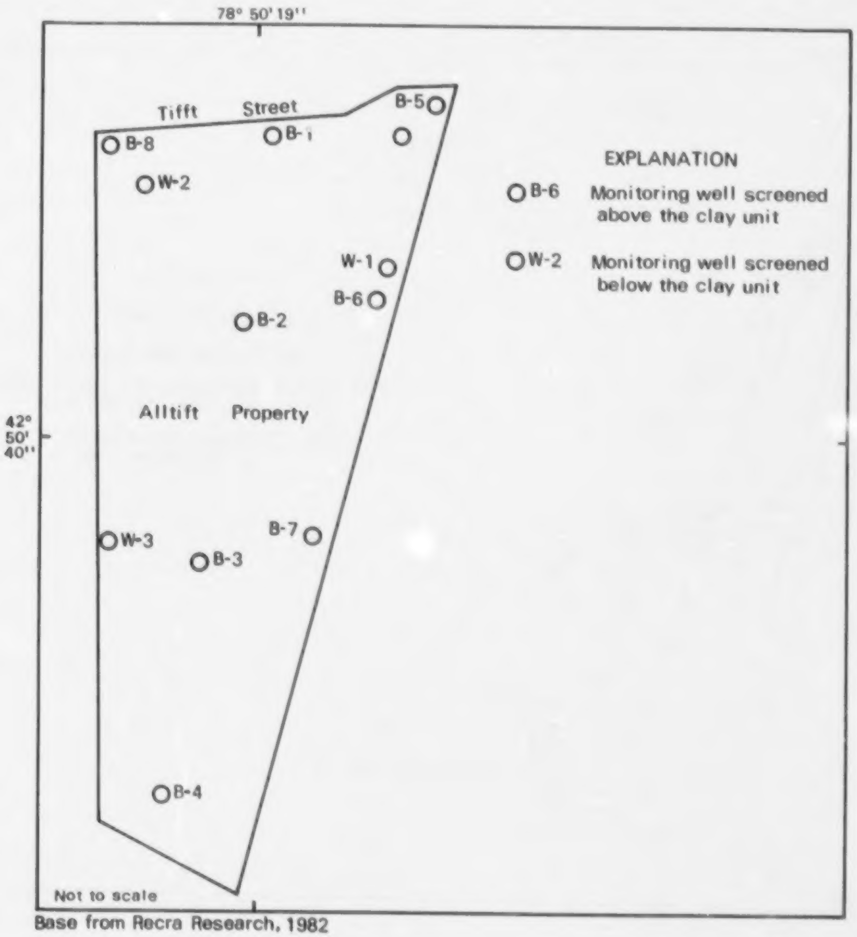
Figure A-11. Potentiometric surface and location of sampling holes at Republic Steel, site 148, Buffalo, August 1979 and February 1982.

162. ALLTIFT LANDFILL (Literature review) NYSDEC 915054

General information and contaminant-migration potential.--The Alltift Landfill, a 25-acre area south of the city of Buffalo, has been a disposal site since the 1950's. From the 1950's to the early 1970's, the site was used to dispose of bulk loads of dye, oil sludges, phenolic compounds, chrome sludge, copper sulfate, nitrobenzene, monochlorobenzene, and naphthalene. The amount of material deposited is unknown.

The landfill was inactive from the early 1970's to the late 1970's. Since then it has been used for the disposal of auto-demolition shredder waste, core sands, fly ash, and sand waste at a rate of 40,000 to 60,000 yd^3/yr. The disposal area is now in the northern third of the site (fig. A-12).

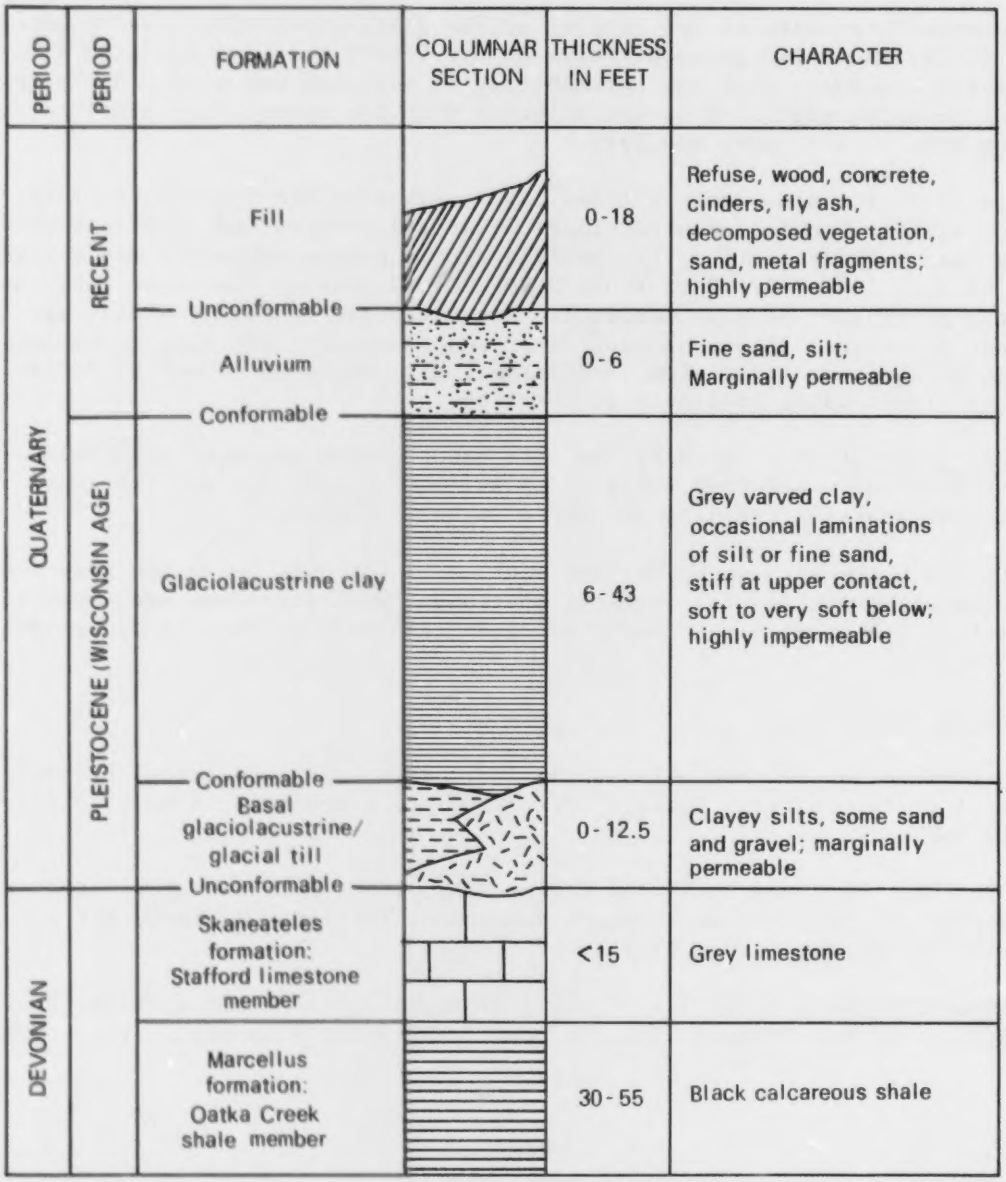
Chemical data suggest that inorganic contaminants are migrating through the clay unit. The concentration of phenols, arsenic, mercury, chlorides, and sulfates in the zone above the clay greatly exceed ground-water standards; therefore, the potential for contaminant migration would become major if the contaminants were to move through the clay and into the lower aquifer.



Base from Recra Research, 1982

Figure A-12. Location of sampling holes at Alltift Landfill, site 162, Buffalo.

Geologic information.--The site consists of alluvium and fill of recent age underlain by till and lacustrine clay, which are in turn underlain by limestone and shale of Devonian age. Two consulting reports--Wehran Engineering and Recra Research (1978) and Recra Research (1982)--discuss these units in detail and include geologic cross sections. A generalized geologic column is shown in figure A-13.



PERIOD	PERIOD	FORMATION	COLUMNAR SECTION	THICKNESS IN FEET	CHARACTER
QUATERNARY	RECENT	Fill		0-18	Refuse, wood, concrete, cinders, fly ash, decomposed vegetation, sand, metal fragments; highly permeable
		— Unconformable —			
		Alluvium		0-6	Fine sand, silt; Marginally permeable
		— Conformable —			
	PLEISTOCENE (WISCONSIN AGE)	Glaciolacustrine clay		6-43	Grey varved clay, occasional laminations of silt or fine sand, stiff at upper contact, soft to very soft below; highly impermeable
		— Conformable —			
		Basal glaciolacustrine/ glacial till		0-12.5	Clayey silts, some sand and gravel; marginally permeable
		— Unconformable —			
DEVONIAN		Skaneateles formation: Stafford limestone member		<15	Grey limestone
		Marcellus formation: Oatka Creek shale member		30-55	Black calcareous shale

Figure A-13. Generalized geologic column of formations underlying the Alltift Landfill, site 162, Buffalo. (Site location is shown in fig. A-12. Modified from Recra Research, Inc., 1982.)

Hydrologic information.--A water-table map of the shallow fill and alluvium by Wehran and Recra (1978) indicates a ground-water mound near the eastern boundary of the site. Water levels in the eight borings used to construct the map ranged from 580.8 to 584.8 ft above NGVD. This mound is probably the result of the relatively impermeable glaciolacustrine clay, which inhibits vertical flow and causes water infiltrating from the surface soils and alluvium to move laterally away from the site.

Permeability tests on two samples of the glaciolacustrine clay by Wehran and Recra (1978) indicated permeabilities of 5.8×10^{-8} cm/s and 6.4×10^{-8} cm/s. The report concluded that the permeability of the clay was sufficiently low to prevent vertical migration of contaminants from the upper unconsolidated water-bearing zone to the lower aquifers.

In 1982, the site owner drilled four borings to the upper part of the bedrock aquifer, collected water-level data, and constructed a potentiometric-contour map. The potentiometric surface slopes gently northward and ranges from 576.3 ft to a low of 574.9 ft above NGVD. Comparison of the water-table and potentiometric-surface maps indicates that the heads beneath the clay are lower and that a vertical flow component is present; however, the rate of movement through the unit would be slow. Additional data would be needed to define the vertical ground-water gradients at the site.

Chemical information.--In 1978, the site owner collected seven ground-water samples from wells screened above the glaciolacustrine clay for inorganic constituent analysis; results are given in table A-14.

In 1982, the site owner drilled four wells screened below the clay and collected water samples for chemical analysis. Well locations are shown in fig. A-12. The samples were analyzed by Recra Research; results are given in table A-15.

Sources of data

Wehran Engineering and Recra Research, Inc., 1978, Hydrogeological investigation of Alltift Landfill, Buffalo, N.Y.: 50 p., 1 appendix, 2 maps, 5 figs., 10 tables.

Recra Research Inc. and Sodarholm Engineering, 1980, Part 360 application for permit to operate a solid waste management facility; Buffalo, N.Y.: Alltift Company, Inc., 22 p., 1 appendix.

Recra Research Inc., 1982, Supplemental hydrogeological investigation, Buffalo, N.Y.: Alltift Company, Inc., 17 p., 1 appendix, 3 tables, 1 fig., 3 prints.

Table A-14.--Analyses of ground-water samples from wells screened above glaciolacustrine clay at the Alltift landfill, site 162, Buffalo, N.Y., July 1978[1]
[Locations shown in fig. A-13. Concentrations are in µg/L except as indicated. NV indicates that value was not reported.]

Constituent or characteristic	Sample number			
	B1	B2	B4	B5
pH	7.28	7.47	6.43	7.10
Specific conductance (µmho/cm at 25°C)	6,000	21,000	11,000	4,000
Dissolved oxygen	5,800	4,300	7,200	4,200
Biochemical oxygen demand, 5-day	359,000	7,020,000	96,500	242,000
Chemical oxygen demand	489,000	2,580,000	593,000	291,000
Coliform, total (organisms/100mL)	130	24,000	230	130
Ammonia, as nitrogen	77,600	1,930,000	73,9000	61,200
Nitrate, as nitrogen	<100	<500	<500	120
Nitrite, as nitrogen	50	50	50	80
Total kjedahl nitrogen, as nitrogen	91,900	1,490,000	106,000	69,200
Phosphate, total (as phosphorous)	556	1,290	44	86
Sulfate	86,300	441,000	2,660,000	387,000
Detergent (Methylene blue active substances	160	50	190	150
Phenols	37	696	50	20
Alkalinity as $CaCO_3$	2,280,000	8,270,000	915,000	1,530,000
Total solids	4,410,000	30,000,000	9,590,000	2,990,000
Color (platinum-cobalt units)	500	NV	200	150
Hardness, total	665,000	1,250,000	2,260,000	665,000
Chlorides	3,630,000	8,450,000	3,880,000	730,000
Total organic carbon	950,000	1,400,000	313,000	110,000
Total halogenated hydrocarbons, as Cl	8.42	38.4	1.32	1.24
PCB	<1.0	<1.0	<1.0	<1.0
Aluminum, total	260	50	240	60
Arsenic, total	6.3	131	<4	5.1
Chromium, total	14	546	<3	10
Chromium, hexavalent	<10	40	<10	<10
Copper, total	<3	26	15	210
Lead, total	<30	<30	<30	<30
Mercury, total	<1.3	3.8	<1.3	<1.3
Potassium, total	98,000	908,000	146,000	118,000
Sodium, total	1,060,000	3,080,000	2,020,000	840,000
Calcium, total	214,000	54,000	760,000	146,000
Silver, total	<2	<2	<2	<2
Iron, total	280	2,430	5,080	160

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[1] Data from Wehran Engineering and Recra Research, 1978.

Table A-14.--Analyses of ground-water samples from wells screened above glaciolacustrine clay at the Alltift landfill, site 162, Buffalo, N.Y., July 1978[1] (continued)
[Locations shown in fig. A-13. Concentrations are in µg/L except as indicated. NV indicates that value was not reported.)

Constituent or characteristic	Sample number		
	B6	B7	B8
pH	7.34	8.00	7.70
Specific conductance (25°C) (µmho/cm)	5,400	7,900	6,000
Dissolved oxygen	6,200	NV	NV
Biochemical oxygen demand, 5-day	605,000	NV	NV
Chemical oxygen demand	379,000	780,000	499,000
Coliform, total (organisms/100mL)	24,000,000	NV	NV
Ammonia, as nitrogen	107,000	259,000	113,000
Nitrate, as nitrogen	<100	<100	<100
Nitrite, as nitrogen	50	70	120
Total kjedahl nitrogen, as nitrogen	125,000	NV	NV
Phosphate, total (as phosphorus)	130	NV	44
Sulfate	240,000	NV	299,000
Detergent (Methylene blue active substances	30	NV	30
Phenols	30	89	71
Alkalinity as $CaCO_3$	1,760,000	2,250,000	2,390,000
Total solids	4,950,000	6,100,000	6,100,000
Color (platinum-cobalt units)	200	NV	700
Hardness, total	594,000	NV	536,000
Chlorides	1,010,000	2,070,000	1,430,000
Total organic carbon	488,000	NV	538,000
Total halogenated hydrocarbons, as Cl	3.33	NV	NV
PCB	<1.0	NV	NV
Aluminum, total	<30	<30	40
Arsenic, total	21.3	15.4	12.2
Chromium, total	6	16	12
Chromium, hexavalent	<10	10	10
Copper, total	5	10	14
Lead, total	<30	<30	<30
Mercury, total	<1.3	10.7	NV
Potassium, total	128,000	182,000	118,000
Sodium, total	1,140,000	1,560,000	1,300,000
Calcium, total	190,000	56,000	18,000
Silver, total	<2	<4	3
Iron, total	30	460	20

[1] Data from Wehran Engineering and Recra Research, 1978.

Table A-15.--Analyses of ground-water samples from four wells screened below glaciolacustrine clay at Alltift landfill, site 162, Buffalo, N.Y, May 1982[1]

[Locations are shown in fig. A-13. Concentrations are in µg/L unless otherwise indicated; LT indicates constituent or compound was found but below quantifiable detection limit.]

Characteristic	Sample number			
	W-1	W-2	W-3	W-4
Ammonia, as nitrogen	2,500	950	740	2,100
Nitrate, as nitrogen	<50	120	<50	170
Biochemical oxygen demand, 5-day	10,000	6,000	<5,000	<5,000
Chemical oxygen demand	16,000	24,000	11,000	23,000
Total kjedahl nitrogen, as N	4,400	2,200	1,700	2,800
Sulfate	29,000	52,000	45,000	54,000
Methylene blue active substances	29	<20	72	160
Total recoverable phenolics	<10	<10	<10	<10
Alkalinity (pH 4.5), as $CaCO_3$	590,000	310,000	350,000	700,000
Total filterable residue (180°C)	1,000,000	480,000	540,000	890,000
pH	7.73	8.11	7.99	12.31
True color (Platinum-cobalt units)	15	15	17.5	2.5
Total hardness, as $CaCO_3$	390,000	250,000	270,000	451,000
Chloride	260,000	88,000	83,000	88,000
Odor (Threshold odor number)	1.8	3.2	9.0	1.4
Specific conductance (µmho/cm at 25°C)	1,780	820	822	2,990
Total organic carbon	5,000	4,500	2,500	9,000
Coliform, total (organisms/100mL)	<3	<3	<3	<3
Aluminum, total	4,300	7,300	2,000	2,200
Arsenic, total	LT	LT	LT	LT
Chromium, total	40	50	64	40
Chromium, hexavalent	6	12	8	LT
Cadmium, total	LT	LT	LT	LT
Zinc, total	1,100	803	1,400	109
Selenium, total	LT	LT	LT	LT
Copper, total	100	38	22	40
Lead, total	30	LT	LT	LT
Mercury, total	LT	LT	LT	LT
Sodium, total	540,000	150,000	14,000	18,000
Calcium, total	68,000	46,000	28,000	170,000
Silver, total	LT	LT	LT	LT
Manganese, total	220	230	200	160
Iron, total	88,000	28,000	35,000	54,000
Nitrogen-phosphorus scan (µg/L as nitrogen; N,N'-dimethylaniline standard)	LT	LT	LT	LT

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[1] Data from Recra Research (1982).

173. EMPIRE WASTE (USGS field reconnaissance) NYSDEC 915065

General information and contaminant-migration potential.--The Empire Waste site, in the northern part of the city of Buffalo, was used for storing sand and slag for resale and also received slag from a metal-castings firm in 1977. The concentrations of copper and zinc in substrates were higher than those in samples collected from undisturbed soils not affected by disposal sites. The potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled four test borings on the site; the locations are shown in fig. A-14. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 4.0	Fill, tannish, then black.
	4 - 6.0	Clay, reddish, discolored. to bluish by overlying fill. SAMPLE: 4 ft.
2	0 - 2.5	Topsoil.
	2.5 - 6.5	Clay, reddish, discolored. SAMPLE: 5.0 ft.
3	0 - 1.5	Topsoil, mixed.
	1.5 - 2.5	Black organic wet dirt.
	2.5 - 5.5	Clay, reddish, dry.
	5.5 - 6.5	Clay, greenish, wet. SAMPLE: 5.5 ft.
4	0 - 3.5	Topsoil, becoming black.
	3.5 - 5.5	Organic dirt, black, wet.
	5.5 - 6.5	Clay, greenish. SAMPLE: 5.5 ft.

Hydrologic information.--No hydrologic data were obtained from the site except for moist material encountered between 3.5 and 5.5 ft at an altitude of 595 ft above NGVD.

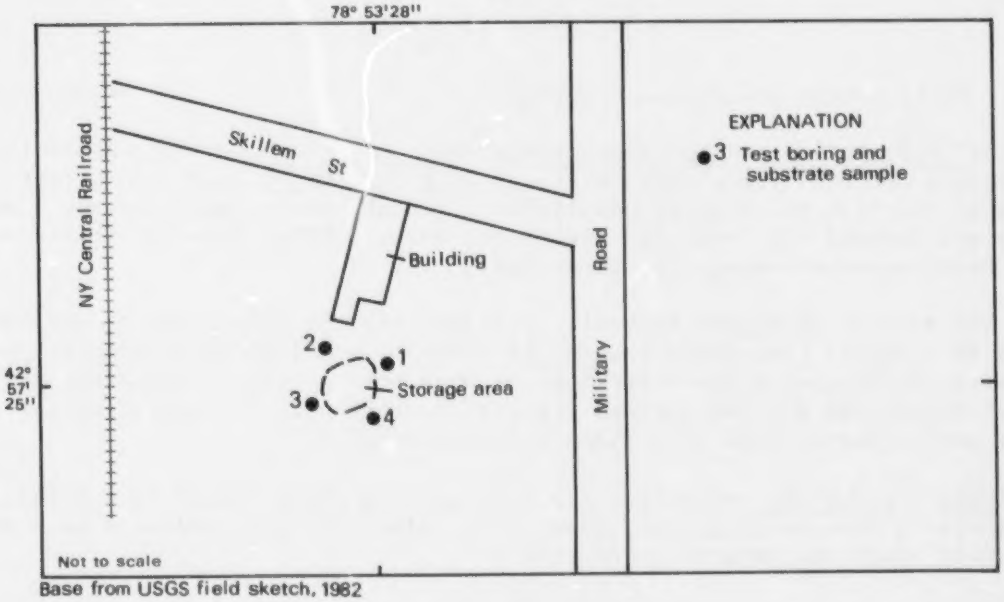
Chemical information.--The U.S. Geological Survey collected a substrate sample at each borehole for arsenic, cadmium, chromium, copper, iron, lead, mecury, and zinc analyses; results are given in table A-16. The substrate samples had higher concentrations of copper and zinc than samples from the undisturbed areas.

Table A-16.--Analyses of substrate samples from Empire Waste, site 173, Buffalo, N.Y., July 30, 1982.

[Locations shown in fig. A-14. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found.]

	Sample number and depth below land surface (ft)			
	1 (4.0)	2 (5.0)	3 (5.5)	4 (5.5)
Inorganic constituents				
Arsenic	--	--	--	--
Cadmium	1,000	—	1,000	—
Chromium	6,000	4,000	4,000	4,000
Copper	90,000††	17,000	95,000††	41,000††
Iron	23,000,000	13,000,000	17,000,000	38,000,000
Lead	30,000	20,000	100,000	40,000
Mercury	--	--	--	--
Zinc	170,000††	40,000	74,000	39,000

†† Exceeds concentrations in samples taken from undisturbed soils in the Buffalo area. Undisturbed soils were not analyzed for iron.



Base from USGS field sketch, 1982

Figure A-14. Location of sampling holes at Empire Waste, site 173, Buffalo.

180. HOPKINS STREET (Literature review) NYSDEC 915011

General information and contaminant-migration potential.--The Hopkins Street site, in the city of Buffalo, is reported to have been used as a landfill in the early and mid-1970's. Aerial photographs from these years indicate disposal operations to have been small and to have caused no major changes in the physical setting of the site.

No chemical monitoring has been recommended by NYSDEC, and the potential for chemical migration is indeterminable.

Geologic information.--No geologic data are available.

Hydrologic information.--No ground-water data are available. However, comparison of aerial photographs from past years with 1982 field observations indicates a change in drainage and grade; also a pond has formed on the site. The pond is probably perched upon fill or material of low permeability and does not reflect ground-water conditions.

Chemical information.--No chemical data are available.

184. KELLY ISLAND (Literature review) NYSDEC 915095

General information and contaminant-migration potential.--Kelly Island is a peninsula bounded by the Buffalo River, City Ship Canal, and Ohio Street. Most of the fill consists of demolition material, earth, and cinders. The area was extensively developed before the early 1900's, leaving little room for hazardous-waste-disposal operations.

The site is in direct hydraulic contact with the Buffalo River and the City Ship Canal; thus contaminants, if present, would migrate readily. However, no hazardous waste is known to have been buried at the site; therefore, NYSDEC has not recommended chemical monitoring. The potential for contaminant migration from this site is indeterminable.

Geologic information.--Construction borings from along Ganson Street (pl. 1) indicated a mixture of gravel, sand, silt, clay, cinders, and wood to a depth of 10 ft along the length of the site.

Hydrologic information.--No hydrologic data are available.

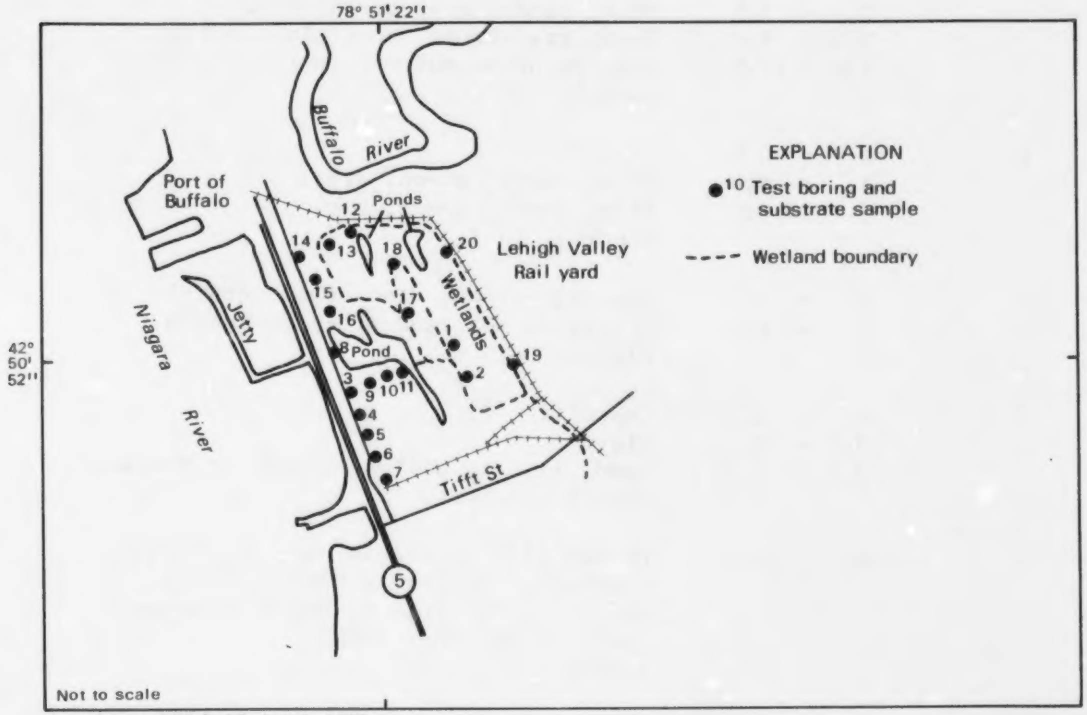
Chemical information.--No chemical data are available.

190. LEHIGH VALLEY RAILROAD (USGS field reconnaissance) NYSDEC 9150781

General information and contaminant-migration potential.--The Lehigh Valley Railroad site, in the southern part of the city of Buffalo, is an abandoned landfill covered with soil and vegetation. The material buried at the site consists of fly ash, pit sludge, foundry sand, and sand slurry. The quantity of material buried is unknown.

The site is underlain by a thick clay deposit that would act as a deterrent to vertical migration of contaminants. Horizontal migration would occur only if precipitation moved through the fill, then laterally along the clay surfaces to eventually discharge westward to the adjacent outer harbor. Cadmium, chromium, copper, and lead were present, but the potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled 20 test holes in July and August of 1982. The locations are shown in figure A-15; geologic logs are as follows:



Base from USGS field sketch, 1982

Figure A-15. Location of sampling holes at Lehigh Valley Railroad, site 190, Buffalo.

Boring no.	Depth (ft)	Description
1	0 - 1.5	Brown soil and black organic material.
	1.5 - 9.0	Clay, olive green, wet.
	9.0 - 16.5	Clay, dark green, wetter.
		SAMPLE: 9 ft.
2	0 - 1.0	Topsoil.
	1.0 - 3.5	Clay, greenish brown.
	3.5 - 21.5	Clay, gray green.
		SAMPLE: 17 ft.
3	0 - 1.5	Topsoil, dark brown, some rock fill.
	1.5 - 3.5	Soil, dark brown.
	3.5 - 4.5	Clay, dark green, dry.
	4.5 - 11.5	Clay, dark green, "soupy."
		SAMPLE: 9 ft.
4	0 - 2.5	Topsoil, brown.
	2.5 - 3.5	Clay, sandy, gray-green, dry.
	3.5 - 8.0	Sand, gray-green, some clay, moist.
	8.0 - 11.5	Same as above but very wet.
		SAMPLE: 10 ft.
5	0 - 3.5	Topsoil.
	3 - 6.0	Clay, sandy, green, dry.
	6 - 9.0	Clay, sandy, green, wet.
		SAMPLE: 10 ft.
6	0 - 3	Topsoil, brown, with rubble-gravel.
	3 - 6.5	Gravel to wet sand, fine to medium.
		SAMPLE: 6.5 ft.
7	0 - 3.3	Topsoil.
	3.3 - 3.5	Clay.
	3.5 - 6.5	Sand, fine to medium, gravel at bottom.
		SAMPLE: 6.5 ft.
8	0 - 21.5	Gravel fill (probably used to elevate roadbed). Extremely hard drilling.
		Gravel wet at 11.5 ft which is about level of adjacent lake.
		SAMPLE: 11.5 ft.
9	0 - 1.5	Topsoil.
	1.5 - 3.5	Sand, dark brown.
	3.5 - 6.5	Sand, dark green, damp.
	6.5 - 11.5	Clay, sandy, dark green, damp.
		SAMPLE: 10.0 ft.
10	0 - 5.5	Topsoil, with clay lenses.
	5.5 - 6.5	Clay, gray-green, wet.
		SAMPLE: 5.5 ft.

Boring no.	Depth (ft)	Description
11	0 - 3.0	Topsoil.
	3.0 - 5.5	Clay, dark green.
	5.5 - 6.5	Clay, dark green, wet. SAMPLE: 5.5 ft.
12	0 - 2.0	Topsoil, black.
	2.0 - 5.5	Sand, dark gray, wet.
	5.5 - 6.5	Clay, gray green. SAMPLE: 2 ft.
13	0 - 2.0	Topsoil, yellow-green at top, darker green downward.
	2 - 4.0	Sand, clayey, dry olive green.
	4.0 - 10.0	Clay, sandy, olive green, yellow at 9 ft. SAMPLE: 2 ft.
14	0 - 3.0	Topsoil.
	3.5 - 6.0	Clay, olive green.
	6.0 - 6.5	Sand, some clay, gray green. SAMPLE: 6 ft.
15	0 - 11.5	Pebble-size fill; moved east toward treeline.
	0 - 3	Topsoil.
	3 - 6	Clay, gray green, damp.
	6 - 6.5	Clay, yellow green, wet. SAMPLE: 3 ft.
16	0 - 3	Topsoil with rocks and rubble.
	3 - 4	Clay, gray green, wet. SAMPLE: 3 ft.
17	0 - 3	Topsoil, iron colored, very hot coming out of hole.
	3 - 6.5	Clay, gray green, getting wetter toward bottom. SAMPLE: 2.5 ft.
18	0 - 2	Topsoil.
	2 - 3	Sand, coarse, gray green.
	3 - 6.5	Clay, gray green, wet. SAMPLE: 2.5 ft.
19	0 - 2.5	Topsoil and gravel, black, wet.
	2.5 - 5.0	Sand, black, very wet.
	5.0 - 6.5	Clay, gray green. SAMPLE: 3.5 ft.
20	0 - 3	Topsoil and gravel, black.
	3 - 6.5	Clay, gray green. SAMPLE: 3 ft.

One test boring was drilled to bedrock. The log is as follows:

0 - 16.5	Black fill material. Hit water table at 10 ft.
16.5 - 56.5	Gray-green clay with some gravel and pebbles.
56.5 - 60.0	Gray-green sandy clay.
60.0	Bedrock.

The well logs suggest glacial lake deposits overlying bedrock and overlain by fill.

Hydrologic information.--The test-boring information suggests a water table within the fill at an altitude between 570 and 575 ft above NGVD. Ground water would probably discharge from the site to the outer harbor.

Chemical information.--In 1982, the Erie County Department of Environment and Planning and NYSDEC took water and sediment samples for chemical analysis. Results indicated significant concentrations of heavy metals and minor quantities of polychlorinated biphenyls and total organic halogens (Erie County Department of Environment and Planning, written commun., 1982).

In 1982, the U.S. Geological Survey collected and analyzed a substrate sample from each of 20 test borings for cadmium, chromium, copper, iron, lead, nickel, and phenols; results are given in table A-17. The concentrations of cadmium, chromium, copper, and lead were higher than in soil samples from the undisturbed areas.

Table A-17.--Analyses of substrate samples from Lehigh Valley Railroad, site 190, Buffalo, N.Y., July-August 1982
[Locations are shown in fig. A-15. Concentrations are in µg/kg, dashes indicate constituent or compound was not found.]

	Sample number and depth below land surface (ft)				
	1 (11.5)	2 (17.0)	3 (9.0)	4 (10)	5 (9.0)
Inorganic constituents					
Cadmium	--	--	--	1,000	1,000
Chromium	1,000	2,000	7,000	6,000	6,000
Copper	17,000	19,000	14,000	16,000	28,000
Iron	7,200,000	10,000,000	5,400,000	4,100,000	2,300,000
Lead	10,000	10,000	50,000	140,000	50,000
Nickel	--	10,000	10,000	10,000	--
Organic compounds					
Priority pollutant					
Phenol	--	--	--	--	--

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†† Exceeds concentrations in soil samples from undisturbed areas. Undisturbed soils were not analyzed for iron.

Table A-17.--Analyses of substrate samples from Lehigh Valley Railroad, site 190, Buffalo, N.Y., July-August 1982 (continued) [Locations are shown in fig. A-15. Concentrations are in µg/kg, dashes indicate constituent or compound was not found.]

	Sample number and depth below land surface (ft)				
	6	7	8	9	10
	(6.5)	(6.5)	(11.5)	(10.5)	(5.5)
Inorganic constituents					
Cadmium	1,000	--	5,000	1,000	2,000
Chromium	7,000	7,000	170,000††	7,000	20,000
Copper	40,000	20,000	44,000††	19,000	45,000††
Iron	3,400,000	12,000,000	20,000,000	7,000,000	10,000,000
Lead	26,000	10,000	35,000	10,000	140,000
Nickel	--	10,000	20,000	20,000	30,000
Organic compound					
Phenol (priority pollutant)	--	--	--	--	--
	11	12	13	14	15
	(5.5)	(2.0)	(2.0)	(6.0)	(4.5)
Inorganic constituents					
Cadmium	14,000††	--	--	--	1,000
Chromium	20,000	10,000	3,000	3,000	10,000
Copper	2,100,000††	3,000	12,000	10,000	21,000
Iron	16,000,000	4,500,000	2,000,000	2,300,000	5,000,000
Lead	1,600,000††	10,000	10,000	10,000	40,000
Nickel	30,000	10,000	--	--	--
Organic compound					
Phenol (priority pollutant)	--	--	--	--	--
	16	17	18	19	20
	(3.0)	(2.5)	(2.5)	(3.5)	(3.0)
Inorganic constituents					
Cadmium	2,000	--	--	1,000	--
Chromium	8,000	9,000	3,000	8,000	4,000
Copper	22,000	25,000	13,000	74,000††	13,000††
Iron	5,900,000	1,400,000	3,500,000	12,000,000	3,700,000
Lead	160,000	30,000	30,000	200,000	20,000
Nickel	10,000	20,000	--	20,000	--
Organic compounds					
Phenol (priority pollutant)	--	--	--	--	--

196. NIAGARA FRONTIER PORT AUTHORITY (USGS field reconnaissance) NYSDEC 915026

General information and contaminant-migration potential.--The Niagara Frontier Port Authority site, at the Buffalo outer harbor, was used by an automotive assembly plant to dispose of an unknown quantity of cafeteria, office, and plant refuse, including paint sludges. The site also contains dredged lake-bottom material and demolition debris as well as an unknown amount of casting sands deposited by a different automobile manufacturer.

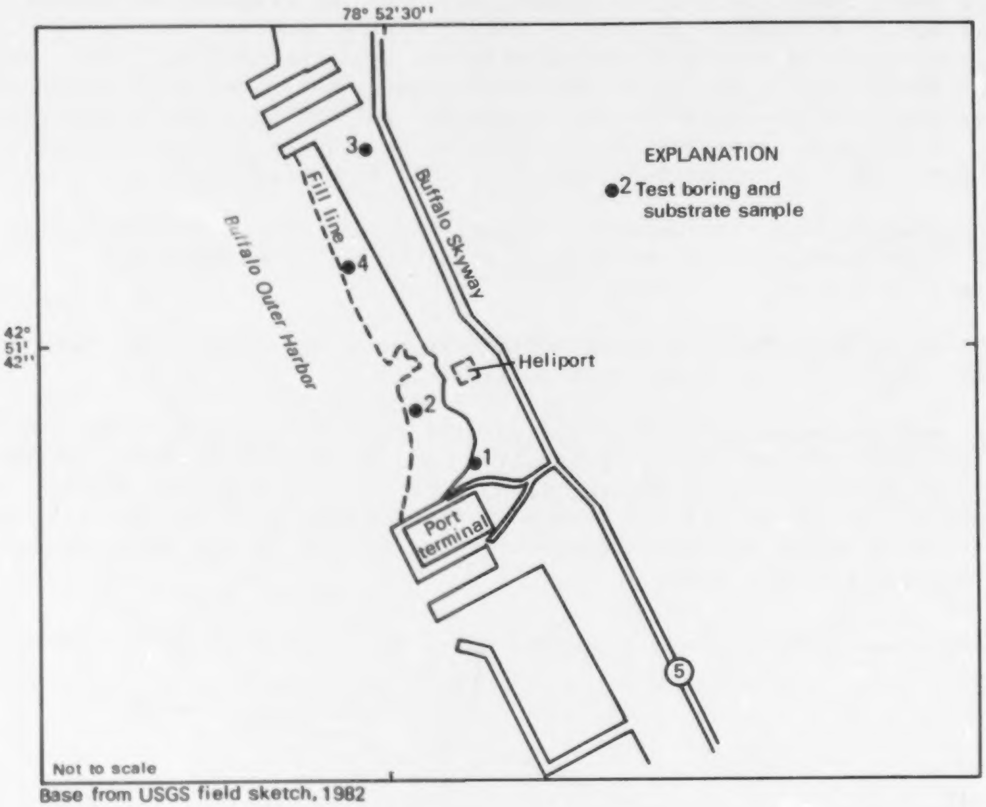
Hydrologic data suggest that chemical migration would most likely be toward the Buffalo harbor. The chemical data, however, do not indicate high concentrations of contaminants on the site and suggest that horizontal migration may not be taking place. Additional data would be needed to evaluate vertical migration; thus the migration potential is indeterminable.

Geologic information.--The site consists of fill material overlying clayey sand. The U.S. Geological Survey drilled four test borings in August 1982. Locations of the borings are shown in figure A-16; logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 10.0	Rock debris, fill.
	10.0 - 16.5	Sand, fine to medium, tan to gray-green at 14 ft, wet. SAMPLE: 13 ft.
2	0 - 5.0	Fill debris.
	5.0 - 6.0	Sand, light blue-green, damp.
	6.0 - 11.5	Sand, clayey, tan.
	11.5 - 13.0	Looks like clay at 12-13 ft, gray, wet. SAMPLE: 12-13 ft.
3	0 - 1.5	Lime, smells like paint.
	1.5 - 3.0	Same.
	3.0 - 6.5	Sand, tan to black, gravel and debris, wet at top.
	6.5 - 11.5	Same, with some clay.
	11.5 - 16.5	Same with more debris: bricks, glass, etc.
	16.5 - 21.5	Hit hard zone at 17 ft; another at about 19 ft.
	21.5 - 26.5	No return--sample off bit. SAMPLE: 26.5 ft.
4	0 - 1.5	Brown sand.
	1.5 - 5.0	Same.
	5.0 - 8.0	Sand, fine to medium, light brown, wet.
	8.0 - 11.5	Sand, olive green, some clay, wetter. SAMPLE: 8.0 ft.

Hydrologic information.--Ground water was encountered at 13 to 14 ft below land surface (590 ft above NGVD); thus, the water-table altitude is 576 to 577 ft above NGVD. The direction of ground-water flow is most likely westward toward the Buffalo harbor.

Chemical information.--The U.S. Geological Survey collected a substrate sample from each test boring for cadmium, chromium, copper, iron, lead, nickel, and phenol analyses; results are given in table A-18. None of the heavy-metal concentrations exceeded those in soil samples from the undisturbed areas.



Base from USGS field sketch, 1982

Figure A-16. Location of sampling holes at Niagara Frontier Port Authority, site 196, Buffalo.

Table A-18.--Analyses of substrate samples from Niagara Frontier Port Authority, site 196, Buffalo, N.Y., August 5, 1982. [Locations shown in fig. A-16. Concentrations are in μg/kg; dashes indicate compound was not found.]

	Sample number and depth below land surface (ft)			
	1 (13.0)	2 (13.0)	3 (26.5)	4 (8.0)
Inorganic constituents				
Cadmium	--	--	1,000	--
Chromium	1,000	2,000	1,000	--
Copper	--	1,000	38,000	--
Iron	58,000	270,000	340,000	130,000
Lead	--	--	60,000	--
Nickel	--	--	--	--

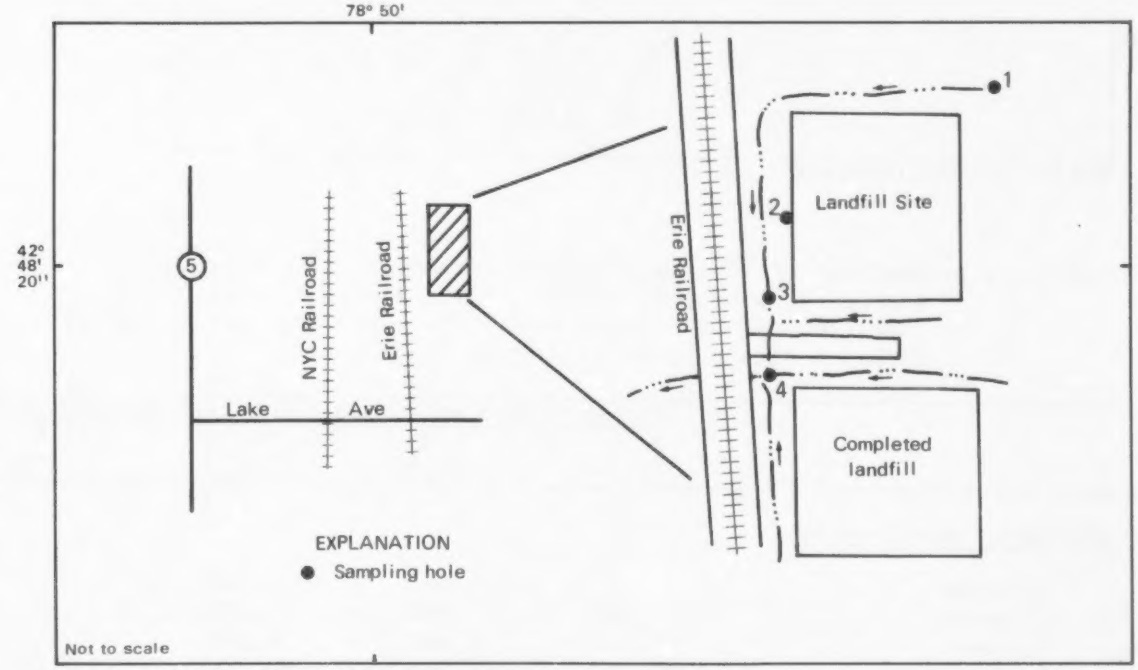
200. PROCKNAL AND KATRA (Literature review) NYSDEC 915085

General information and chemical migration potential.--The Procknal and Katra site is in the Village of Blasdell. The active part of the site receives trash from the Village of Blasdell and bulky material from the City of Lackawanna. The inactive part, immediately to the south, was used for disposal of rubbish from the Village of Blasdell. In January 1982 the site received 200 to 300 yd^3 of sand contaminated with coal-tar derivatives from National Fuel Gas. This material was buried with 1,000 lb of dehydrated lime. Analyses of the water and soil samples show low concentrations of metals and polycyclic aromatic hydrocarbons (PAH). A complete assessment of the site would require more subsurface data. The potential for contaminant migration is indeterminable.

Geologic information.--No site-specific geologic information is available, but the site is in an area in which the bedrock consists of Skaneateles and Marcellus shale and thin limestone.

Hydrologic information.--No monitoring wells have been installed; therefore, no site-specific hydrologic information is available.

Chemical information.--The company collected soil and water samples from four different locations in 1982; sampling locations are shown in fig. A-17. Water samples were analyzed for heavy metals, iron, total organic halogens (TOH), total organic carbon (TOC), and PAH; the soil samples were analyzed for all but TOC. A leachate breakout was observed at site 2. Results of the soil and water analyses are given in table A-19.



Base from USGS field sketch, 1982

Figure A-17. Location of sampling holes at Procknal and Katra, site 200, Blasdell.

Table A-19.--Analyses of surface-water and substrate samples from Procknal and Katra, site 200, Buffalo, N.Y., April 27, 1982.[1] [Locations shown in fig. A-17. Concentrations are in µg/L and µg/kg; LT indicates it was found but below the quantifiable detection limit.]

	Surface-water sample		
	1	3	4
Inorganic constituents			
Antimony	LT	LT	LT
Arsenic	LT	LT	LT
Beryllium	LT	LT	10
Cadmium	10	LT	LT
Chromium	4	4	LT
Copper	58	30	40
Iron	410	2,200	1,000
Lead	40	40	40
Mercury	LT	LT	LT
Nickel	LT	60	60
Selenium	LT	LT	LT
Silver	LT	LT	LT
Thallium	LT	LT	LT
Zinc	LT	120	97
Organic compounds			
Total Organic Carbon	2,000	8,000	14,000
Total Organic Halogen, asCl_2 (Lindane standard)	0.38	0.64	1.1
Polycyclic aromatic compounds			
Acenaphthene	LT	LT	LT
Acenaphthylene	LT	LT	LT
Anthracene	LT	LT	LT
Benzo(a)anthracene	LT	LT	LT
Benzo(a)pyrene	LT	LT	LT
Benzo(b)fluoranthene	LT	LT	LT
Benzo(ghi)perylene	LT	LT	LT
Benzo(k)fluoranthene	LT	LT	LT
Chrysene	LT	LT	LT
Dibenzo(a,h)anthracene	LT	LT	LT
Fluoranthene	LT	LT	LT
Fluorene	LT	LT	LT
Indeno(1,2,3-cd)pyrene	LT	LT	LT
Naphthalene	LT	LT	LT
Phenanthrene	0.047	0.45	0.51
Pyrene	LT	LT	LT

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[1] Samples analyzed by Procknal and Katra, 1982.

Table A-19.--Analyses of surface-water and substrate samples from Procknal and Katra, site 200, Buffalo, N.Y., April 27, 1982[1] (continued) [Locations shown in fig. A-17. Concentrations are in µg/L and µg/kg; LT indicates it was found but below the quantifiable detection limit.]

	Substrate sample number and depth below land surface (ft)			
	1	2	3	4
Dry weight percent	(46)	(76)	(12)	(72)
Inorganic constituents				
Antimony	LT	LT	110,000	8,700
Arsenic	27,000	2,600	49,000	4,400
Beryllium	LT	LT	LT	LT
Cadmium	2,000	400	29,000	1,400
Chromium	24,000	9,100	46,000	8,300
Copper	570,000	21,000	170,000	18,000
Iron	350,000	200,000	1,700,000	240,000
Lead	44,000	10,000	220,000	49,000
Mercury	LT	LT	LT	LT
Nickel	11,000	2,000	98,000	11,000
Selenium	500	770	4,200	440
Silver	LT	LT	LT	--
Thallium	LT	6,600	22,000	2,900
Zinc	59,000	34,000	280,000	34,000
Organic compounds				
Total organic halogen, as Cl_2 (Lindane standard)	1,600	1,500	2,400	560
Polynuclear aromatic compounds				
Acenaphthene	LT	LT	LT	LT
Acenaphthylene	LT	LT	LT	370
Anthracene	500	LT	290	480
Benzo(a)anthracene	3,500	LT	1,400	LT
Benzo(a)pyrene	4,200	550	2,300	LT
Benzo(b)fluoranthene	4,600	LT	1,900	LT
Benzo(ghi)perylene	6,600	LT	2,600	LT
Benzo(k)fluoranthene	3,800	LT	2,200	LT
Chrysene	5,600	130	1,700	370
Dibenzo(a,h)anthracene	12,000	2,000	2,600	LT
Fluoranthene	5,600	320	3,100	LT
Fluorene	340	LT	94	180
Indeno(1,2,3-cd)pyrene	1,820	LT	1,900	LT
Naphthalene	420	LT	240	370
Phenanthrene	6,500	36	880	1,100
Pyrene	5,100	LT	3,700	LT

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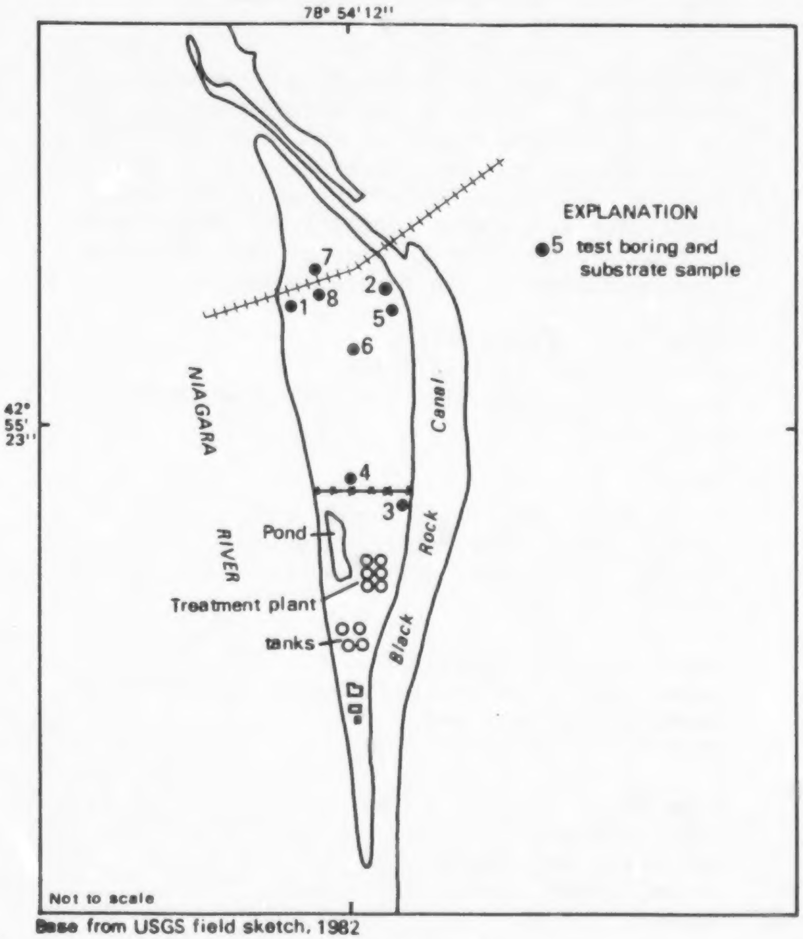
[1] Analyses by Procknal and Katra, 1982.

203. SOUAW ISLAND (USGS field reconnaissance) NYSDEC 915052

General information and contaminant-migration potential.--Squaw Island is between the Niagara River and the Black Rock Canal, which borders the mainland of the city of Buffalo. The site accepted foundry sand with phenolic binders, incinerator residue, street sweepings, forest debris, and general refuse for more than 3 decades. During 1954-70, the island was used for the disposal of waste foundry sand containing clay, insoluble metal compounds, trace oils, and resins. The rate of disposal is estimated to have been 300,000 to 400,000 tons per year. In the mid-1970's, much of the fill was excavated and transferred to the Tifft Farm (site 206, pl. 1).

The highly permeable foundry sand that was used to fill and increase the size of the island indicates a major potential for migration of contaminants to the Niagara River and the Black Rock Canal. Any leachate would readily percolate to the water table and migrate to the surrounding water bodies.

Geologic information.--The site contains a thin mantle of till and unsorted sediments overlying limestone bedrock. The U.S. Geological Survey drilled eight test borings in 1982. Locations of the test holes are shown in fig. A-18; the geologic logs are on page 146.



Base from USGS field sketch, 1982

Figure A-18. Location of sampling holes on Squaw Island, site 203, Buffalo.

Boring no.	Depth (ft)	Description
1	0 - 3.0	Topsoil, black.
	3.0 - 8.0	Clay, red, tight.
	8.0 - 10.0	Clay, sandy, damp, greenish.
	10.0 - 15.0	Same, but wetter.
	15.0 - 17.0	Same, but tighter. Sample depth may be at lower altitude than river surface.
		SAMPLE: 10 ft.
2	0 - 5.0	Black, organic topsoil.
	5.0 -11.5	Gray cinder ash, glass, etc., getting wet at about 10 ft.
	11.5 - 16.5	Same.
	16.5 - 21.5	No return.
		SAMPLE: 10 ft.
3	0 - 1.5	Light gray cinder ash.
	1.5 - 8.0	Dark brown dirt, dry, changing to dark gray at about 6 ft.
	8.0 - 11.5	Clay, tan to dirty yellow, damp.
		SAMPLE: 8 ft.
		Note.--Drill was moved several times to miss rock fill.
4		No drilling log was obtained, only a sample from 11.5-ft depth. A considerable amount of the waste fill was removed and redeposited at Tifft Farms. The area once occupied by the fill is now covered by additions to the municipal waste-treatment facilities. Well 4 was drilled at the southern edge of the additions (southern edge of the removal area).
5	0 - 1.5	Black soil, fill, rocky.
	1.5 - 6.5	Whitish rocky fill material.
	6.5 - 11.5	Brown, wet, rocky fill into wet green clay.
		SAMPLE: 7.5 ft.
6	0 - 1.5	Fill.
	1.5 - 6.5	Black oily soil, fill, smells wet.
	6.5 - 11.5	Black, sandy, clay, oily, water.
	11.5 - 16.5	Black, sandy, clay, oily, water.
		SAMPLE: 16 ft.
7	0 - 1.5	Brown topsoil, rocky fill.
	1.5 - 6.5	Loose soil, black to red clay, 1 in thick.
	6.5 - 11.5	Green sandy clay, wet.
		SAMPLE: 11 ft.
8	0 - 1.5	Road fill.
	1.5 - 6.5	Fill, rubble.
	6.5 - 11.5	Red clay, wet, tight.
	11.5 - 16.5	Green, sandy, clay.
		SAMPLE: 16 ft.

Hydrologic information.--Ground water was encountered at approximately the same altitude as the water surface in the Niagara River and the Black Rock Canal. The direction of ground-water flow would be toward these water bodies.

Chemical information.--The U.S. Geological Survey collected a substrate sample from each test boring for chromium, copper, iron, and organic-compound analysis; results are given in table A-20. The substrate samples had higher concentrations of chromium and copper than soil samples from undisturbed areas. The samples contained 17 organic priority pollutants; the highest concentration among these compounds (fluoranthene) was 330 µg/kg; 25 organic nonpriority pollutants and some unknown hydrocarbons were also found.

Table A-20.--Analyses of substrate samples from Squaw Island, site 203, Buffalo, N.Y. [Locations shown in fig. A-18. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit, blanks indicate not analyzed.]

	Sample number and depth below land surface (ft)			
	1	2	3	4
First sampling (07-29-82)	(10.0)	(10.0)	(8.0)	(11.5)
Inorganic constituents	***	***		
Chromium			8,000	20,000††
Copper			17,000	1,700,000††
Iron			6,400,000	15,000,000
Molecular sulfur			LT	--
Organic compounds	***	***		
Priority pollutants				
Fluoranthene			--	330
Bis(2-ethylhexl) phthalate			--	LT
Dibenzo(a,h)anthracene			--	LT
Pyrene			--	LT
Nonpriority pollutants				
1,1-Ethanediol, diacetate[1]			1,100	--
4-Methyl-2-pentanone[1]			2,300	--
2-Butanone[1]			4,800	--
2-Methylheptane[1]			640	420
2,3,4-Trimethyl hexane[1]			780	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples from undisturbed areas in Buffalo area. Undisturbed soils were not analyzed for iron.

* Compounds detected but not quantified--Holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

*** Inadequate sample. No analyses performed.

Table A-20.--Analyses of substrate samples from Squaw Island, site 203, Buffalo, N.Y. N.Y. (continued)
[Locations shown in fig. A-18. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit, blanks indicate not analyzed.]

	Sample number and depth below land surface (ft)			
	1	2	3	4
First sampling (07-29-82)	10.0	10.0	8.0	11.5
Organic compounds (continued)				
Nonpriority pollutants (continued)				
2,6-Dimethylheptane[1]			1,100	750
1,3,5-Cycloheptatriene[1]			330	--
3-Methylheptane[1]			370	--
2,2'-[methylenebis(oxy)]-bis propane[1]			380	--
3-Methyl-1-pentanol[1]			LT	--
2-Methyl-2-propyl-1,3-dioxylane [1]			680	--
2-Methyl-2-hexanol[1]			340	--
2,3,3,4-Tetramethylpentane[1]			--	1,500
1,2-Dimethylbenzene[1]			--	800
1,4-Dimethylbenzene[1]			--	LT
Propyl benzene [1]			--	580
1-Ethyl-2-methylbenzene[1]			--	820
1,2,3-Trimethylbenzene			--	420
2-Methyl-1-heptene[1]			--	LT
3-Ethyl-hexane[1]			--	370
4-Penten-2-one[1]			--	LT
2,2,3-Trimethylbutane[1]			--	460
1-Methyl-4-propylbenzene[1]			--	LT
2-Chloro-1-phenyl-ethanone[1]			--	LT
2,4,4-Trimethylhexane[1]			--	350
2-Chloronaphthalene[1]			--	LT
1-Methyl-7-(1-Methylethyl)-phenanthrene[1]			--	LT
5-Ethyl-5-propylundecane[1]			--	LT
2-Cyclohexen-1-one[1]			430	--
3-Methyl-2-pentanone[1]			--	1,100

	Sample number and depth below land surface (ft)			
	5 (7.5)	6 (16.0)	7 (11.0)	8 (16.0)
Inorganic constituents				
Chromium	5,000	9,000	10,000	4,000
Copper	69,000††	37,000	550,000††	12,000
Iron	56,000,000	74,000,000	79,000,000	72,000,000
Organic compounds				
Priority pollutant				
Pyrene	730	--	--	--

Table A-20.--Analyses of substrate samples from Squaw Island, site 203, Buffalo, N.Y. (continued)
[Locations shown in fig. A-18. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit, blanks indicate not analyzed.]

	Sample number and depth below land surface (ft)			
First sampling (07-29-82)	5 (7.5)	6 (16.0)	7 (11.0)	8 (16.0)
Organic compounds (continued)				
Nonpriority pollutants				
5-Methyl nonane[1]	--	--	420	--
2,2,5-Trimethyl-3,4-hexanedione[1]	--	--	500	--
2H-pyran-2-one[1]	--	--	570	--

	Sample number and depth below land surface (ft)	
Second sampling (05-18-83)	1 (12.0)	2 (14.0)
Inorganic constituents		
Molecular sulfur[1]	810	270
Organic compounds		
Priority pollutants		
Benzene	--	6.0
Acenaphthene	*	*
Fluoranthene	*	*
Naphthalene	*	*
Bis(2-ethylhexl) phthalate	--	*
Di-n-butyl phthalate	--	*
Di-n-octyl phthalate	--	*
Benzo(a)anthracene	*	*
Benzo(a)pyrene	*	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	*
Chrysene	*	*
Acenaphthalene	*	*
Fluorene	*	*
Phenanthrene	*	--
Dibenzo(a,h)anthracene	*	*
Indeno(1,2,3-cd)pyrene	*	*
Pyrene	*	*
Nonpriority pollutants		
Benzoic acid	--	*
4-Methylphenol	*	--
Dibenzofuran	*	*
2-Methylnaphthalene	*	*
3,4-Dihydro-2,5,7,8-tetramethyl-2-		*
(4,18,12-trimethyl)-2H-1-		
benzopyren-1-ol[1]	*	--
Unknown hydrocarbons[1]	*	*

206. TIFFT FARM (Literature review) NYSDEC 915072

General information and contaminant-migration potential.--The Tifft Farm site, in the southwestern part of the city of Buffalo, was a disposal site for material hauled from Squaw Island (site 203, pl. 2) during the mid-1970's. The site was designed with clay barrier walls and base and a leachate-collection system. The site was capped with a clay seal and has been incorporated into a nature preserve. Subsurface investigations were not included as a part of this site-assessment program.

216. ERIE BASIN MARINA (Literature review) NYSDEC 915013

General information and contaminant-migration potential.--The Erie Basin Marina is on Lake Erie at the mouth of the Buffalo River in the city of Buffalo. Construction of the site began in 1972 and was completed in the mid-1970's. The fill is reported to consist of 90 percent slag from a steel corporation and 10 percent construction and demolition material from area buildings that were being torn down. The site is in direct hydraulic contact with the Buffalo River and Lake Erie; thus contaminant migration would be likely. No hazardous waste is reported to be deposited at the site. The potential for contaminant migration from the site is indeterminable.

Geologic information.--The site is a manmade area built out into the water. It consists of a slag and hard fill base overlain by imported soil and underlain by lake deposits.

Hydrologic information.--The fill material is in direct contact with Lake Erie; thus any ground water at the site would mix directly with lake water. All surface runoff would also flow directly into the Buffalo River or Lake Erie.

Chemical information.--No evidence of hazardous waste was found; therefore, no water or soil analyses were made.

217. DONNER HANNA COKE COMPANY (USGS field reconnaissance) NYSDEC 915017

General information and contaminant-migration potential.--The Donner Hanna Coke Company, in the southern part of the city of Buffalo, was a disposal area for ammonium sulfate and water-treatment-plant solids. The site is now used for coke storage.

The potential for vertical migration of contaminants is probably minimal because an extensive clay unit underlies the site. The geologic cores and results of an electromagnetic survey indicate the area of fill to be larger than visual inspection of the site would indicate. All samples were taken within the disposal area; thus, more data would be needed to determine the potential for horizontal migration offsite. The potential is indeterminable at present.

Geologic information.--The U.S. Geological Survey drilled four test borings in August 1982. Locations are shown in fig. A-19; the geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 4.0	Black coke, fill material.
	4.0 - 5.0	Clay, dark olive green, wet.
	5.0 - 10.0	Clay, tan to yellowish, dry, tight, getting wet at about 8 ft and sandy.
		SAMPLE: 5 ft.
2	0 - 3.5	Topsoil and rubble, debris.
	3.5 - 6.0	Clay, sandy, gray-green, "soupy", becomes drier and tighter at 4.0.
		SAMPLE: 3.5 ft.
3	0 - 2.5	Topsoil and coke debris, black.
	2.5 - 5.0	Asphaltic-looking, watery material with gravel. Volatile sensing meter reading of 20 (2.5 background) Meter setting of 9 - calibrated for benzene. smells less asphaltic than in first hole.
	5.0 - 6.0	Clay, gray, green.
		SAMPLE: 3.5 ft.
4	0 - 3.0	Coke bed material, bricks, wood, etc.
	3.0 - 5.0	Sand, black, very coarse, damp.
	5.0 - 6.0	Soupy, black material. Sample would not burn.
	6.0 - 6.5	Clay, greenish, wetter than in other holes.
		SAMPLE: 5.5 ft.

Hydrologic information.--The test borings indicate a zone of ground water at 4 to 6 ft below land surface. This ground-water zone may be perched, as suggested by the second well log.

Chemical information.--The U.S. Geological Survey collected a substrate sample from each test boring for cyanide, iron, and organic compound analyses; results are given in table A-21. The samples revealed no cyanide but contained 21 organic priority pollutants, 18 organic nonpriority pollutants, and some unknown hydrocarbons.

Electromagnetic survey information.--The U.S. Geological Survey conducted an electromagnetic survey in November 1982; results are shown in figure A-20. The line both begins and ends in a wetland. The conductivity values recorded within the wetland, as well as those outside the wetland, show high readings of conductivity that possibly indicate buried waste (fig. A-20). The pattern of readings around the 420-ft mark would normally be considered evidence of buried metal but here may reflect remnants of a large coke pile that once occupied the area (fig. A-20). (Coke, a form of carbon, has a conductivity similar to that of metal.)

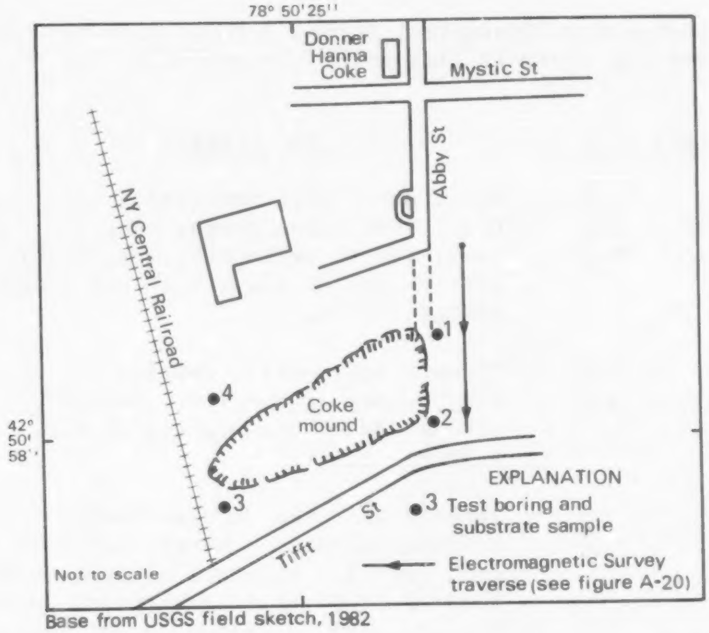

Figure A-19. Location of sampling holes and electromagnetic-conductivity survey lines at Donner Hanna Coke, site 217, Buffalo.

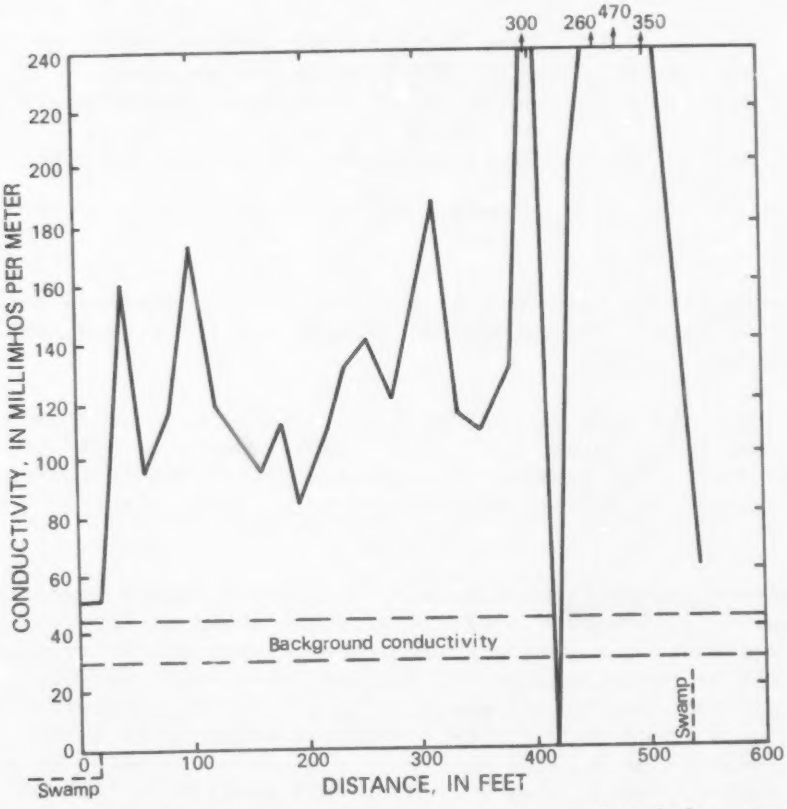

Figure A-20. Results of electromagnetic-conductivity survey at Donner Hanna Coke, site 217, Buffalo. (Location is shown in fig. A-19.)

Table A-21.--Analyses of substrate samples from Donner Hanna Coke, site 217, Buffalo, N.Y.
[Locations shown in fig. A-19. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1	2	3	4
First sampling (08-05-82)	(5.0)	(3.5)	(3.5)	(5.5)
Inorganic constituents				
Cyanide	--	--	--	--
Iron	8,100,000	5,000,000	5,200,000	2,400,000

	Sample number (depths are same as in first sampling)			
Second sampling (05-18-83)	1A	2A	3A	4A
Inorganic constituents				
Molecular sulfur[1]	27,000	680	--	--
Organic compounds				
Priority pollutants				
Benzene	14.0	18.5	37.8	51.8
Ethylbenzene	--	--	3.8	--
Toluene	2.5	--	21.6	--
2,4-Dimethylphenol	--	*	--	--
Phenol	--	*	--	--
Acenaphthene	--	*	*	*
Fluoranthene	*	*	*	*
1,2-Dichlorobenzene	--	*	--	--
Naphthalene	*	*	*	*
Benzo(a)anthracene	--	*	*	*
Benzo(a)pyrene	--	*	*	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	*	*	*

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified--Holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

Table A-21.--Analyses of substrate samples from Donner Hanna Coke, site 217, Buffalo, N.Y. (continued)

[Locations shown in fig. A-19. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number (depths are same as first sampling)			
Second sampling (continued)	1A	2A	3A	4A
Organic Compounds (continued)				
Priority pollutants (continued)				
Chrysene	--	*	*	*
Acenaphthylene	--	*	*	--
Anthracene	--	*	--	*
Benzo(ghi)perylene	--	*	*	--
Fluorene	--	*	*	*
Phenanthrene	--	*	*	*
Dibenzo(a,h)anthracene	--	*	--	--
Indeno(1,2,3-cd)pyrene	--	*	*	--
Pyrene	*	*	*	*
Nonpriority pollutants				
Acetone	399	346	--	--
Carbon disulfide	--	--	83.7	--
2-Hexanone	--	--	41.5	--
O-xylene	3.7	5.7	69.8	4.7
2-Methylphenol	--	*	--	--
4-Methylphenol	--	*	--	--
Dibenzofuran	--	*	*	*
2-Methylnaphthalene	--	*	*	*
9H-Carbazole[1]	--	*	--	--
3-Methylphenanthrene[1]	--	*	--	--
Hexadecanoic acid[1]	--	*	--	--
1-Methylpyrene[1]	--	*	--	--
Trichlorofluoromethane[1]	--	--	*	--
Methylcyclohexane[1]	--	--	*	--
4-Methyl-2-pentanone[1]	--	--	*	--
2,6,6-Trimethyl-bicyclo(3.1.1)-hepten-2-ene[1]	--	--	*	--
1,3- and 1,4-Dimethyl-benzene[1]	--	--	*	--
1-Ethenyl-2-methylbenzene[1]	--	--	*	--
Unknown hydrocarbons[1]	--	*	*	--

219. HARTWELL STREET LANDFILL (Literature review) NYSDEC 915030

General information and contaminant-migration potential.--This landfill, at the west end of Hartwell Street in the northern part of the city of Buffalo, contains earth fill, wood pallets, pieces of trucks, metal products, and construction and demolition debris. No evidence of hazardous waste has been reported. The potential of contaminant migration is indeterminable.

Geologic information.--No data are available. The overburden is estimated to be 60 to be 80 ft thick.

Hydrologic information.--No data are available. No surface water or wetlands are within a mile of the site.

Chemical information.--NYSDEC, Region 9, inspected this site on March 29, 1982, and collected water and soil samples from three locations--ponded water on the east side of the landfill, ponded water on the west side near the Atlas Steel Company property (see pl. 1), and from a sump in the basement of a house adjacent to the landfill. The latter two samples contained lead in excess of USEPA drinking-water criteria and the New York State standard for ground water as well as detectable concentrations of chromium, copper, zinc, and total organic carbon. The substrate samples contained relatively high amounts of copper, nickel, and zinc, and detectable amounts of chromium, lead, and silver.

220. WEST SENECA TRANSFER STATION (USGS field reconnaissance) NYSDEC 915039

General information and contaminant-migration potential.--The West Seneca Transfer Station site, in the town of West Seneca, was used during 1930-70 for the disposal of municipal refuse. The site also contained an incinerator facility, which was replaced in 1970 by a solid waste-transfer station that is still in operation.

Although the site is adjacent to the Buffalo River, the potential for horizontal and vertical migration could not be evaluated. The potential for contaminant migration is indeterminable.

Geologic information.--The site contains about 20 ft of fill and refuse underlain by a layer of sand, silt, and clay overlying shale bedrock. The shale is approximately 40 ft below land surface.

The U.S. Geological Survey drilled four test borings in August 1982; the locations are shown in fig. A-21. The geologic logs are on p. 156.

Hydrologic information.--Ground water was found between 6.5 and 11.5 ft below land surface. The land surface is approximately 590 ft above NGVD; thus the water-table altitude ranges from 580 to 585 ft above NGVD.

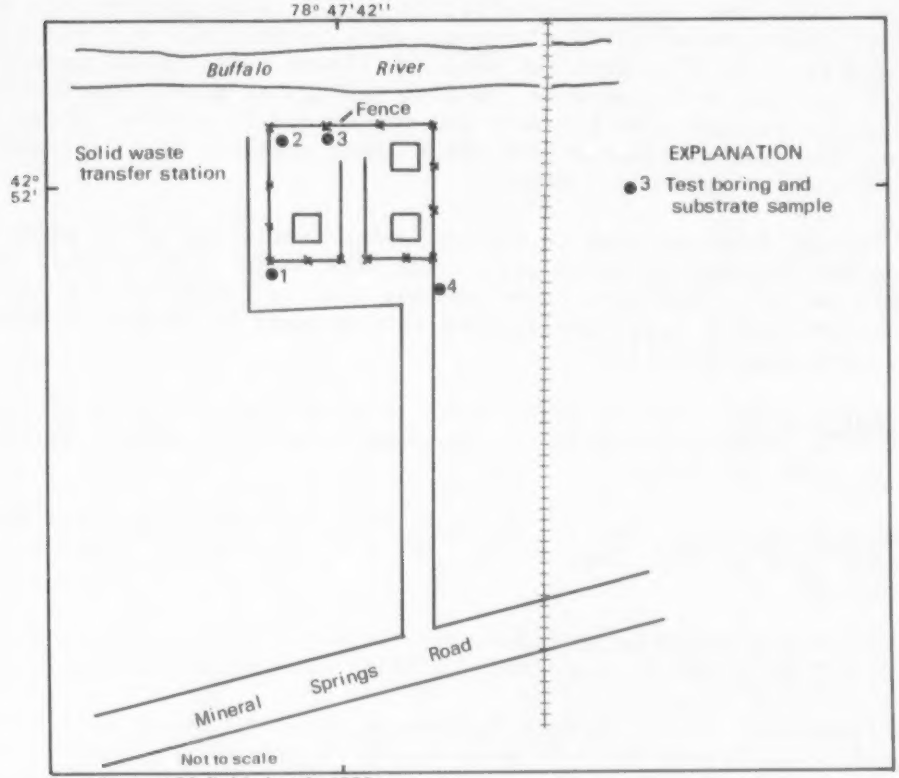
Chemical information.--The Geological Survey collected a soil sample from each test boring for arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and organic compound analysis; results are shown in table A-22. A duplicate sample was taken from boring 3. The substrate sample contained elevated concentrations of copper and lead. Copper in sample 2 exceeded heavy-metal concentrations in soil samples from undisturbed areas.

Boring no.	Depth (ft)	Description
1	0 - 1.5	Dirt, fill, rocky.
	1.5 - 6.5	Fill, black, smelly.
	6.5 - 11.5	Fill, black, smelly, wet.
	11.5 - 16.5	Fill, black, wet, smelly.
	16.5 - 21.5	Gray clay, wet, gravel.
		SAMPLE: wet gray clay at 21.5 ft.
2	0 - 1.5	Black fill, dirt and rocks.
	1.5 - 6.5	Black fill, fine, green, wet.
	6.5 - 11.5	Wet black fill, dirt, fine, green.
	11.5 - 16.5	Same as above, with gravel.
	16.5 - 21.5	Wet gray clay.
		SAMPLE: 21.5 ft.
3	0 - 1.5	Brown dirt, topsoil.
	1.5 - 6.5	Brown dirt, loose to gray clay, wet, black to brown dirt.
	6.5 - 11.5	Brown, sandy dirt with gravel.
	11.5 - 16.5	Same as above.
		SAMPLE: 16.5 ft.
4	0 - 1.5	Dirt, fill, very rocky.
	1.5 - 6.5	Gray clay to brown wet sand.
	6.5	Wet brown sand.
		SAMPLE: 6.5 ft.

Table A-22.--Analyses of substrate samples from West Seneca Transfer Station, Buffalo, N.Y., August 26, 1982.
[Locations shown in fig. A-21. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found.)

	Sample number and depth below land surface (ft)				
	1 (21.5)	2 (21.5)	3 (16.5)	(Split)	4 (6.5)
Inorganic constituents					
Arsenic	1,000	1,000	--	(--)	--
Cadmium	1,000	1,000	--	(--)	--
Chromium	5,000	5,000	4,000	(4,000)	1,000
Copper	20,000	81,000††	9,000	(5,000)	--
Iron	8,100,000	7,200,000	3,000,000	(1,700,000)	1,200,000
Lead	20,000	70,000	10,000	(--)	--
Mercury	--	--	--	(--)	--
Nickel	10,000	10,000	--	(--)	--
Organic compounds	--	--	--	(--)	--

†† Exceeds concentrations in samples taken from undisturbed soils in the Buffalo area. Undisturbed soils were not analyzed for iron.



Base from USGS field sketch, 1982

Figure A-21. Location of sampling holes at West Seneca Transfer Station, site 220, West Seneca.

241. TIMES BEACH CONTAINMENT SITE (USGS field reconnaissance) NYSDEC 915080

General information and contaminant-migration potential.--This site is a 46-acre strip of land with a 1,600-ft by 400-ft pond in the city of Buffalo along Lake Erie. The site was used during 1971-76 for disposal of dredge spoils from the Buffalo River, Buffalo Harbor, and the Black Rock Canal (fig. A-22). It was abandoned in 1976 with 20 acres of open water left. Approximately 550,000 yd^3 of dredged material was deposited on the site.

During 1983, the U.S. Geological Survey maintained a surface-water-stage gaging station at the site and obtained 15-min interval stage records for both Lake Erie and the containment pond. Summaries of hourly lake stages were obtained from the National Oceanographic and Atmospheric Agency and were plotted against hourly values of pond stage. Results indicate that, in the absence of major abrupt changes, the pond stage fluctuates with the lake stage but with a lag of about 1 hour. The lake and pond stages fluctuated as much as 2.5 ft, but normal daily fluctuations ranged from 0.3 to 0.4 ft. Seasonal fluctuations were not greater than the diurnal fluctuations. At regular 6-hour periods, the lake stage rises faster and remains higher than the pond stage, which causes inflow to the pond. When the lake stage falls, it recedes more rapidly than the pond stage, which causes water to flow from the pond to the lake for extended periods. Rates of outflow from the pond are slower than inflow rates; the average outflow rate calculated by the U.S. Geological Survey was 2.5 Mgal/d. The rate is seldom less than 1 Mgal/d and may exceed 10 Mgal/d. Under low-wind conditions, the diurnal fluctuations alone could probably cause a complete exchange of pond water every 2 weeks.

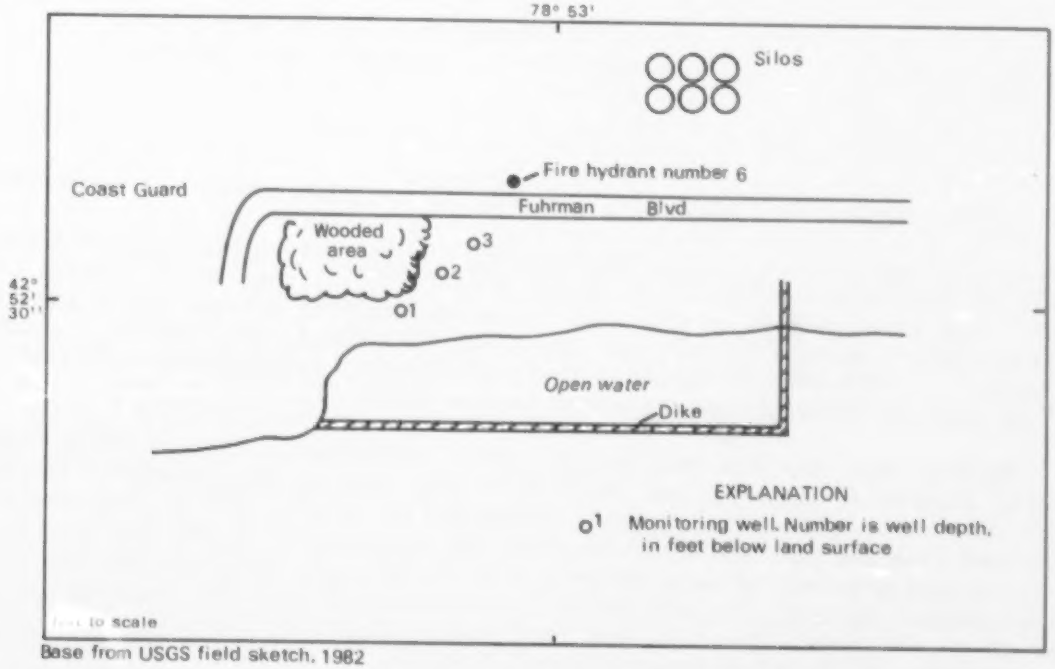
The barrier does not seem to prevent water from entering or leaving the pond; thus any leachate produced within the site would readily enter Lake Erie and Buffalo Harbor. This site therefore has a major potential for contaminant migration. Additional water-quality monitoring would be needed to define the rate of contaminant migration.

Geologic information.--The dredged sediments on the area consist of sand, silt, and clay. The underlying bedrock is Onondaga Limestone overlain by natural lake deposits of silt and clay.

Hydrologic information.--The U.S. Geological Survey installed three monitoring wells in the area in 1982 (fig. A-22). The well data and geologic logs are given on p. 159.

Access to the wells is obtained from Fuhrman Avenue across from fire hydrant 6, 1.5 mi south of Coast Guard station entrance (fig. A-22).

The 12-ft well is 150 ft from Fuhrman Boulevard; the 8-ft well is 240 ft from the 12-ft well; and the 4-ft well is 180 ft from the 8-ft well. All wells emitted a strong petroleum odor, and an oily film was seen on water surface in each.



Base from USGS field sketch, 1982

Figure A-22. Location of monitoring wells at Times Beach disposal site, site 241, along Lake Erie, Buffalo.

Well no.	Depth (ft)	Description
1	0 - 1.0	Organic muck. Depth to water surface approximately 0.5 ft.
	1 - 4.0	Sandy-silty loam. Entire well was augered.
2	0 - 8.0	Surface layer of organic muck. Became sandier with depth. Depth to water surface 0.5 ft to 1 ft. Entire well was augered.
3	0 - 12.0	Surface layer of organic muck. Became sandier with depth. Well was augered to about 8 ft below land surface into sandy loam. Because of slumping, well was driven the remaining 4 ft of depth. Depth to water approximately 1 ft. Light gray material at 7 ft below land surface.

Chemical information.--In the summer of 1981, the U.S. Army Corps of Engineers collected 16 sediment samples from the site and analyzed them for selected metals and organic compounds; results are given in table A-23 and A-24, respectively.

In January 1983, the U.S. Geological Survey collected samples from the three monitoring wells and the containment pond for priority-pollutant analysis; results are given in table A-25. The samples were from dredge spoils and therefore were not compared to State and Federal standards. The samples contained 19 organic priority pollutants; benzene exceeded the New York State standard in all three wells. Also 10 organic nonpriority pollutants and 5 organic compounds potentially of natural origin were found.

Table A-23.--Range and mean concentration of selected metals in 16 sediment samples from Times Beach containment site, site 241, Buffalo, N.Y.[1] [Concentrations are in μg/kg. Dashes indicate that values were not calculated.]

	Method of extraction					
	HNO_3			DPTA		
Inorganic constituents	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Zinc	1,031,000	1,845,000	1,283,000	84,000	202,000	150,000
Cadmium	10,900	13,300	11,900	500	3,000	1,760
Copper	238,000	269,000	251,000	10,000	33,000	21,400
Iron	54,000	74,000	64,000	810	1,070	940
Manganese	619,000	723,000	694,000	77,000	114,000	91,000
Arsenic	2,000	58,900	22,700	90	290	170
Mercury	2,900	9,400	4,800	<50	--	--
Nickel	49,000	63,000	55,000	4,200	7,000	5,300
Chromium	302,000	393,000	332,000	350	470	400
Lead	156,000	1,037,000	497,000	82,000	421,000	191,000

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[1] Data from U.S. Army Corps of Engineers.

Table A-24.--Analyses of 16 sediment samples from Time Beach containment site, site 241, Buffalo, N.Y.[1]
[Concentrations are in $\mu g/kg$.]

	Minimum	Maximum	Mean
Organic compounds			
Bis (2-ethylhexyl) phthalate	1,500	5,500	3,000
PCB (Aroclor 1242)	420	1,000	750
PCB (Aroclor 1254)	620	2,500	1,500
Aniline	1,700	2,800	2,300
1-amino/napthalene	1,700	4,100	2,700
N-benzyl-N-ethyl/aniline	2,400	7,000	4,500
4-(dimethyl/amino)benzophenone	<100		
4,4-methylene bis,(N,N-dimethyl/aniline)	540	1,400	930
N, N, N', N'-tetramethylbenzidine	<100		
p, p'-benzylidene bis (N,N-dimethyl/aniline)	2,600	4,700	3,300
benzo-(a)-pyrene	20,000	96,000	39,000
Chlordane	<200		
Toxaphene	<200		
Dimethyl phthalate	<200		
Diethyl phthalate	<200		
Dibutyl phthalate	<200		
Benzylbutyl phthalate	<200		
Lindane	<100		
Heptaclor	<100		
Aldrin	<100		
p, p'-DDE	<100		
Dieldrin	<100		
Endrin	<100		
p, p'-DDD	<100		
p, p'-DDT	<100		
Methoxyclor	<100		
Mirex	<100		
Phenol	<1,700		
1,2-dichlorobenzene	830	9,800	3,500
1,3-dichlorobenzene	1,200	9,500	3,900
1,4-dichlorobenzene	8,000	22,000	12,000
Naphthalene	11,000	20,000	14,000
Phenanthrene	10,000	15,000	13,000
Anthracene	7,000	13,000	9,700
Fluoranthene	10,000	24,000	17,000
Pyrene	9,800	27,000	17,000
Benzo/(a)/anthracene	6,200	23,000	12,000
Chrysene	7,200	26,000	14,000

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[1] Data from U.S. Army Corps of Engineers.

Table A-25.--Analyses of water samples from Times Beach Containment Site, site 241, Buffalo, N.Y., January 11, 1983.

[Locations shown in fig. A-22. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	Ground water			Surface water
	1 (4)	2 (8)	3 (12)	4 (0.5)
pH	6.8	7.1		7.4
Specific conductance (µmho/cm at 15°C)	1,750	2,100		485
Inorganic constituents				
Aluminum	3,130	2,500	95,800	30,500
Antimony	24†	--	--	31†
Arsenic	66†	106†	30	115†
Barium	187†	280†	2,320†	331†
Beryllium	--	--	--	--
Boron	--	--	--	--
Cadmium	7.8	5.8	17†	39†
Chromium	101†	72†	496†	758†
Cobalt	--	--	220	--
Copper	102	64	1,250†	912
Iron	60,700†	30,900†	63,600†	130,000†
Lead	239†	195†	3,560†	2,020†
Manganese	3,020†	496†	19,200†	2,930†
Mercury	0.96†	--	--	--
Nickel	--	--	659	129
Selenium	--	--	--	--
Silver	--	--	--	--
Thallium	--	--	--	--
Tin	--	--	--	66
Vanadium	--	--	--	--
Zinc	18,200†	4,100	761,000†	3,340
Organic compounds				
Priority pollutants				
Benzene	370†	42†	35†	--
Chlorobenzene	4,600	360	270	LT
Ethylbenzene	25	18	46	--
Toluene	15	--	7.7	--
Acetone	--	--	LT	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

Table A-25.--Analyses of water samples from Times Beach Containment Site, site 241, Buffalo, N.Y., January 11, 1983 (continued)
[Locations shown in fig. A-22. Concentrations are in μg/L; dashes indicate that constituent or compound was not found, LT indicates was found but below the quantifiable detection limit.]

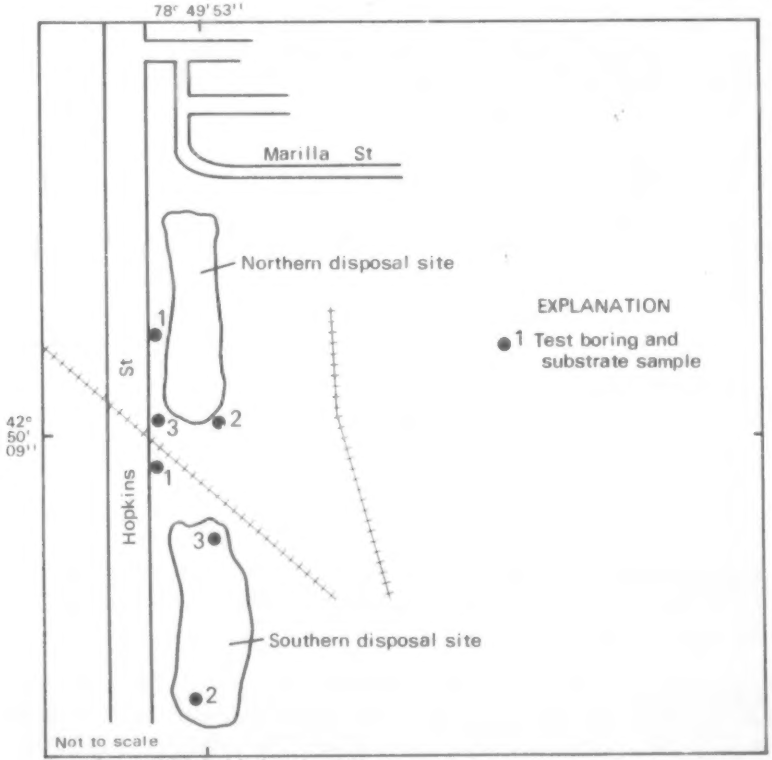
	Sample number and depth below land surface (ft)			
	Ground water			Surface water
	1 (4)	2 (8)	3 (12)	4 (0.5)
Organic compounds (continued)				
Priority pollutants (continued)				
2-Chlorophenol	39	--	--	--
1,2-dichlorobenzene	--	--	230	--
1,3-dichlorobenzene	--	--	22	--
1,4-dichlorobenzene	49	--	120	--
1,2,4-trichlorobenzene	--	--	77	--
N-nitrosodiphenylamine	48	--	24	38
Bis(2-ethylhexyl)phthalate	30	--	81	--
Aniline	35	--	--	--
4-Chloroaniline	430	--	--	--
Naphthalene	--	--	100	--
Benzo(b)fluoranthene	--	--	--	LT
Benzo(k)fluoranthene	--	--	--	LT
Chrysene	--	--	--	LT
Anthracene	--	--	--	LT
Nonpriority pollutants				
O-xylene	32	LT	--	--
Fluoranthene	--	--	--	9.2
Methylcyclopentane[1]	180	74	64	--
Hexane	2,500	1,100	1,000	--
4-Ethyl-2-methylhexane[1]	--	40	--	--
4-Methylbenzeneamine[1]	470	--	--	--
2-Chlorobenzeneamine[1]	300	--	53	--
3-Ethyl-5-methylpyridine[1]	110	--	--	--
2,4-Dimethylheptane[1]	--	33	--	--
1,3-Dimethylbenzene[1]	--	6.8	--	--
3-Hexanone[1]	--	--	35	--
2-Hexanone[1]	--	--	35	--
3-Hexanol[1]	--	--	23	--
2-Hexanol[1]	--	--	37	--
1-Hexanol[1]	--	--	12	--

249. ALLIED CHEMICAL (HURWITZ-RANNE) HOPKINS STREET (USGS field reconnaissance) NYSDEC 915120

General information and chemical-migration potential.--The Hopkins Street site, in the southern part of the city of Buffalo, consists of two parcels of land having different owners. Site information indicates that neither area was used for disposal or lagooning, but NYSDEC received information that burial trenches had been operated on both areas.

Geologic data indicate a limited potential for contaminant migration from the northern property. Vertical migration of contaminants on the southern property is unlikely because the site is underlain by clay. Organic priority pollutants and a high chromium concentration suggest a possibility of contaminant migration, but the potential is indeterminable at this time.

Geologic information.--The two sites consist of 3 to 4 ft of fill and debris underlain by extensive clay. The U.S. Geological Survey drilled six test holes in August 1982 and another six in May 1983. Locations are shown in figure A-23. The geologic logs are as follows:



Base from USGS field sketch, 1982

Figure A-23. Location of sampling holes at Allied Chemical, Hurwitz-Ranne Hopkins Street, site 249, Buffalo.

South Property

Boring no.	Depth (ft)	Description
1	0 - 3.5	Topsoil, dark brown.
	3.5 - 4.0	Clay, sand, with oily fluid. SAMPLE: 3.5 ft.
2	0 - 3.0	Fill, slag.
	3.0 - 5.0	Clay, dark green to yellow, wet. SAMPLE: 4 ft.
3	0 - 2.5	Topsoil, gray, gravel, turning. green at 1.0 ft.
	2.5 - 3.0	Clay, greenish, gray. SAMPLE: 2.5 ft.

North Property

Boring no.	Depth (ft)	Description
1	0 - 2.5	Topsoil and fill.
	2.5 - 3.0	Clay, green, tight.
	3.0 - 4.0	Clay, greenish-gray, wet. SAMPLE: 3 ft.
2	0 - 4.0	Fill, debris.
	4.0 - 5.0	Clay, green, wet.
	5.0 - 6.5	Clay, yellow, wet. SAMPLE: 4 ft.
3	0 - 3.0	Fill, debris, black.
	3.0 - 3.5	Hard zone, rock, and gravel.
	3.5 - 4.5	Clay, green, wet.
	4.5 - 6.5	Clay, yellow. SAMPLE: 3.5 ft.

Hydrologic information.--Test-boring data indicate a perched water table within the clay unit 3 to 4 ft below land surface. The altitude of this water table is approximately 580 ft above NGVD.

Chemical information.--The U.S. Geological Survey collected a soil sample from each test boring for chromium, iron, and organic compound analysis; results are given in table A-26. The samples contained 28 organic priority pollutants. The Erie County Department of Environment and Planning sampled the site; PCB's were detected in surface soils.

Table A-26.--Analyses of substrate samples from Allied Chemical (Hurwitz-Ranne), site 249, Hopkins Street, Buffalo, N.Y.

[Locations shown in fig. A-23. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
	North Property		
First sampling (8-11-82)	1 (3.0)	2 (4.0)	3 (3.5)
Inorganic constituents			
Chromium	30,000	180,000††	340,000††
Iron	10,000,000	28,000,000	29,000,000

	South Property			
	1 (3.5)	Duplicate sample	2 (4.0)	3 (2.5)
Chromium	30,000	(20,000)	180,000††	3,000
Iron	10,000,000	(10,000,000)	21,000,000	3,700,000

	Sample number (depths are same as in first sampling)					
	North Property			South Property		
Second sampling (5-18-83)	1A	2A	3A	1A	2A	3A
Organic compounds						
Priority pollutants						
Benzene	LT	19.1**	22.6	3.4	27.9	10.6
Methylene chloride	--	314**	538	--	313	--
Toluene	--	--	LT	--	2.8	--
Heptachlor	--	--	LT	--	--	--
2,4-Dimethylphenol	--	--	--	*	--	--
Phenol	--	--	--	*	--	--
Pentachlorophenol	--	--	--	--	--	* **
Acenaphthene	*	*	*	*	*	*
1,2-Diphenylhydrazine as azobenzene	--	--	--	--	--	*
Fluoranthene	*	* **	*	*	*	*

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples from undisturbed soils in the Buffalo area. Undisturbed soils were not analyzed for iron.

* Compounds detected but not quantified--Holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

** Surrogate recoveries were outside the acceptance limits.

Table A-26.--Analyses of substrate samples from Allied Chemical (Hurwitz-Ranne), site 249, Hopkins Street, Buffalo, N.Y. (continued)
[Locations shown in fig. A-23. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number (depths are same as in first sampling)					
	North Property			South Property		
Second sampling (continued)	1A	2A	3A	1A	2A	3A
Organic compounds (continued)						
Priority pollutants (continued)						
Naphthalene	*	*	*	*	*	*
Bis(2-ethylhexl) phthalate	*	--	--	--	*	--
Di-n-butyl/phthalate	*	* **	*	*	*	*
Diethyl/phthalate	*	--	--	--	--	*
Di-n-octyl/phthalate	--	--	--	*	--	--
Benzo(a)anthracene	*	* **	*	*	*	*
Benzo(a)pyrene	*	* **	*	*	*	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	* **	*	*	*	*
Chrysene	*	* **	*	*	*	*
Acenaphthylene	*	*	*	*	--	--
Anthracene	--	--	--	*	--	--
Benzo(ghi)perylene	*	* **	*	*	*	--
Fluorene	--	*	*	*	--	--
Phenanthrene	--	--	--	*	--	--
Dibenzo(a,h)anthracene	*	* **	*	*	--	--
Indeno(1,2,3-cd)pyrene	*	* **	*	*	*	*
Pyrene	--	* **	*	*	*	*
N-nitrosodiphenyl-amine	--	--	--	*	--	--
Nonpriority pollutants						
Acetone	--	328**	696	--	--	--
2-Butanone	--	--	165	--	--	--
Carbon disulfide	--	55.5**	100	13.4	121	--
O-xylene	--	31.2**	--	--	--	--
4-Methylphenol	--	--	--	*	*	--
Dibenzofuran	*	*	*	*	*	--
2-Methylnaphthalene	*	*	*	*	*	*
2-Hexanone	--	--	--	--	*	*
4-Methyl-2-pentanone	--	--	--	--	*	*
Tetrahydrofuran[1]	--	*	*	--	*	--
3,2,1-Bicyclooctane[1]	--	*	--	--	--	--
2-Methylphenol	--	--	--	*	--	--
Cis-octahydropentelene[1]	--	*	--	--	--	--
Cis-1,2-dimethylcyclo-hexane[1]	--	*	--	--	--	--
Ethylcyclohexane[1]	--	*	--	--	--	--
2,6,6-Trimethyl-(3.1.1) bicyclo-hept-2-ene[1]	--	*	--	--	--	*

Table A-26.--Analyses of substrate samples from Allied Chemical (Hurwitz-Ranne), site 249, Hopkins Street, Buffalo, N.Y. (continued)
[Locations shown in fig. A-23. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number (depths are same as in first sampling)					
	North Property			South Property		
Second sampling (continued)	1A	2A	3A	1A	2A	3A
Organic compounds (continued)						
Nonpriority pollutants (continued)						
6,6-Dimethyl-2-methylene-bicyclo-(3.1.1)-heptane[1]	--	*	--	--	--	--
1,2,3-Trimethycyclohexane[1]	--	*	--	--	--	--
2-Methylnaphthalene[1]	--	--	--	*	--	--
1,8-Dimethylnaphthalene[1]	--	--	--	*	--	--
Carbazole[1]	--	--	--	*	--	--
3-Methylphenanthrene[1]	--	--	--	*	--	--
9-Methylphenanthrene[1]	--	--	--	*	--	--
2-Phenylnaphthalene[1]	--	--	--	*	--	--
1-Methylpyrene[1]	--	--	--	*	--	--
7-Methyl-benzo(a)-anthracene[1]	--	--	--	*	--	--

253. SMALL BOAT HARBOR CONTAINMENT SITE (USGS field reconnaissance)

General information and contaminant-migration potential.--This site lies along Lake Erie south of the Small Boat Harbor in the city of Buffalo and is operated by the Niagara Frontier Transportation Authority. The site was used for disposal of dredge spoils from the Buffalo River, Buffalo Harbor, and the Black Rock Canal (fig. A-24). This site was the first of three containment sites constructed and was a prototype for other containment sites--Times Beach (site 241) and Buffalo Harbor (site 254).

If the barrier is similar to the one at the Times Beach containment site (site 241), it would not prevent water from entering or leaving the site, and any leachate produced within the site would readily enter Buffalo Harbor. Therefore, this site has potential for contaminant migration. Additional water-quality monitoring would be needed to define the rate of contaminant migration.

Geologic information.--The dredged sediments on the area consist of sand, silt, and clay. The underlying bedrock is Onondaga Limestone overlain by natural lake deposits of silt and clay.

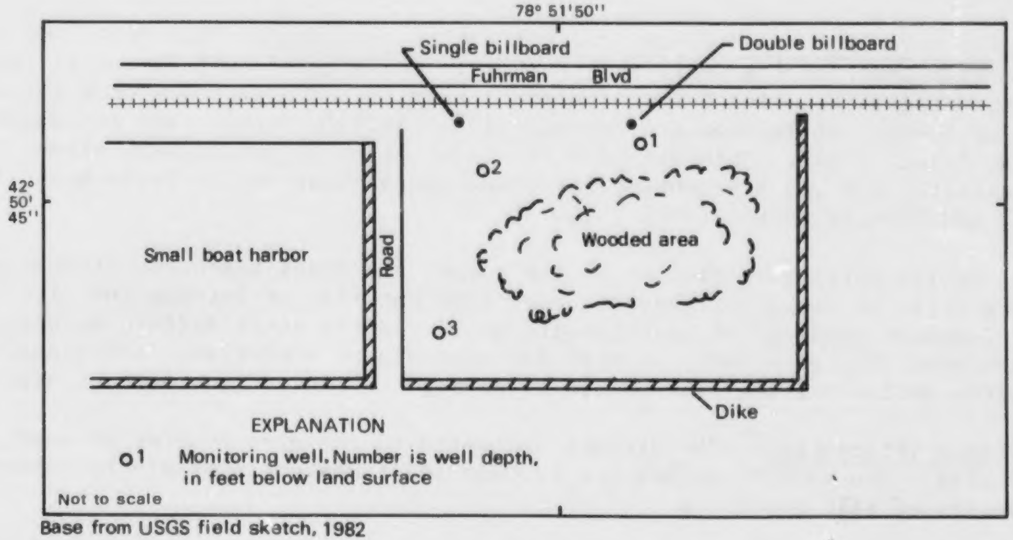
Hydrologic information.--The U.S. Geological Survey installed three monitoring wells in the area in 1982. The well data and geologic logs are as follows:

Well no.	Depth (ft)	Description
1	0 - 4.0	Organic clays. Depth to water surface less than 0.5 ft. Sandier at depth. Entire well was augered.
2	0 - 8.0	Organic clays and fine silts. Became sandier with depth. Coarse, granular material at about 3.5 ft. Depth to water surface about 5 ft (sandy loam). Entire well was augered.
3	0 - 12.0	Organic clays and fine silts through entire depth. Well approximately 2 ft below lake level, however, well yielded little water. Entire well was augered.

Well 1 is in the northwest corner of the site, approximately 150 ft south of the northern dike and 100 ft east of western dike. Well 2 is in the northeast corner of the site, 50 ft south of the billboard and 170 ft west of the road. Well 3 is in the east-central part of the site, 6 ft south of the double billboard and 50 ft west of the road.

All wells emitted a strong petroleum odor, and an oily film was seen on water surface in each. Vegetation around well 1 was dying.

Chemical information.--In January 1983, the U.S. Geological Survey collected samples from the three monitoring wells and the containment pond for USEPA priority-pollutant analysis; results are given in table A-27. These samples are dredge spoils and therefore were not compared to State and Federal criteria. The samples also contained 16 organic nonpriority pollutants and two organic compounds potentially of natural origin.



Base from USGS field sketch, 1982

Figure A-24. Location of monitoring wells at Small Boat Harbor Containment Site, site 253, along Lake Erie, Buffalo.

Table A-27.--Analyses of water samples from Small Boat Harbor Containment Site, site 253, Buffalo, N.Y., January 11, 1983.
[Locations shown in fig. A-24. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	Ground water			Surface water
	1 (4)	2 (8)	3 (12)	4 (0.5)
pH	6.9	6.9		7.4
Specific conductance (µmho/cm)	3,200	2,900		400
Inorganic constituents				
Priority pollutants				
Aluminum	6,320	2,470	2,280	234
Antimony	21†	--	--	--
Arsenic	83†	21†	28†	--
Barium	268†	148†	143†	--
Beryllium	--	--	--	--
Boron	--	374	--	--
Cadmium	14†	3.4	12†	--
Chromium	238†	30	99†	--
Cobalt	--	--	--	--
Copper	214	--	69	--
Iron	79,800†	12,400†	116,000†	497†
Lead	893†	44†	135†	--
Manganese	3,430†	2,220†	4,630†	39
Mercury	--	--	0.90†	--
Nickel	84	--	59	--
Selenium	--	--	--	--
Silver	--	--	--	--
Thallium	--	--	--	--
Tin	48	--	--	--
Vanadium	--	--	--	--
Zinc	12,500†	2,810	18,100†	14
Organic compounds				
Priority pollutants				
Benzene	19†	LT†	46†	--
Chlorobenzene	2,200	14	290	--
Toluene	LT	--	--	--
Ethylbenzene	--	--	11	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or the New York State standard for maximum concentration in ground water.

Table A-27.--Analyses of water samples from Small Boat Harbor Containment Site, site 253, Buffalo, N.Y., January 11, 1983 (continued)
[Locations shown in fig. A-24. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number			
	Ground water			Surface water
	1	2	3	4
Organic compounds (continued)				
Priority pollutants (continued)				
1,3-dichlorobenzene	LT	--	62	--
N-nitrosodiphenylamine	46†	--	25†	--
1,4-dichlorobenzene	--	26	--	--
Bis(2-ethylhexyl) phthalate	--	LT	LT	--
Di-n-octyl phthalate	--	--	--	LT
Nonpriority pollutants				
O-xylene	LT	--	18	--
2-Methylbutane[1]	2.8	--	--	--
Methylcyclopentane[1]	15	--	15	--
Hexane[1]	41	--	--	--
1,3-Dimethyl-cis-cyclopentane[1]	7.4	--	--	--
1,1,3-Trimethylcyclopentane[1]	8.4	--	--	--
2-Chlorobenzeneamine[1]	10	--	--	--
2,4-Dimethylheptane[1]	--	37	8.0	--
3,5-Dimethylheptane[1]	--	38	9.8	--
Cyclohexane[1]	--	--	8.3	1,600
Methylcyclohexane[1]	--	--	41	--
1-Nonanol[1]	--	--	9.0	--
1-Chloro-2-methylbenzene[1]	--	--	13	--
2-Chlorobenzeneamine[1]	--	--	21	--
4-Fluorobenzeneamine[1]	--	--	--	32
Compounds potentially of natural origin				
Undecane[1]	--	--	18	--
Eicosane[1]	--	--	11	--

254. BUFFALO HARBOR CONTAINMENT SITE (USGS field reconnaissance)

General information and contaminant-migration potential.--This site, on Lake Erie near the Bethlehem Steel Plant in the city of Lackawanna, at the intersection of Route 5 and Ridge Road (pl. 1), was used for disposal of dredge spoils from the Buffalo River, Buffalo Harbor, and the Black Rock Canal (fig. A-25).

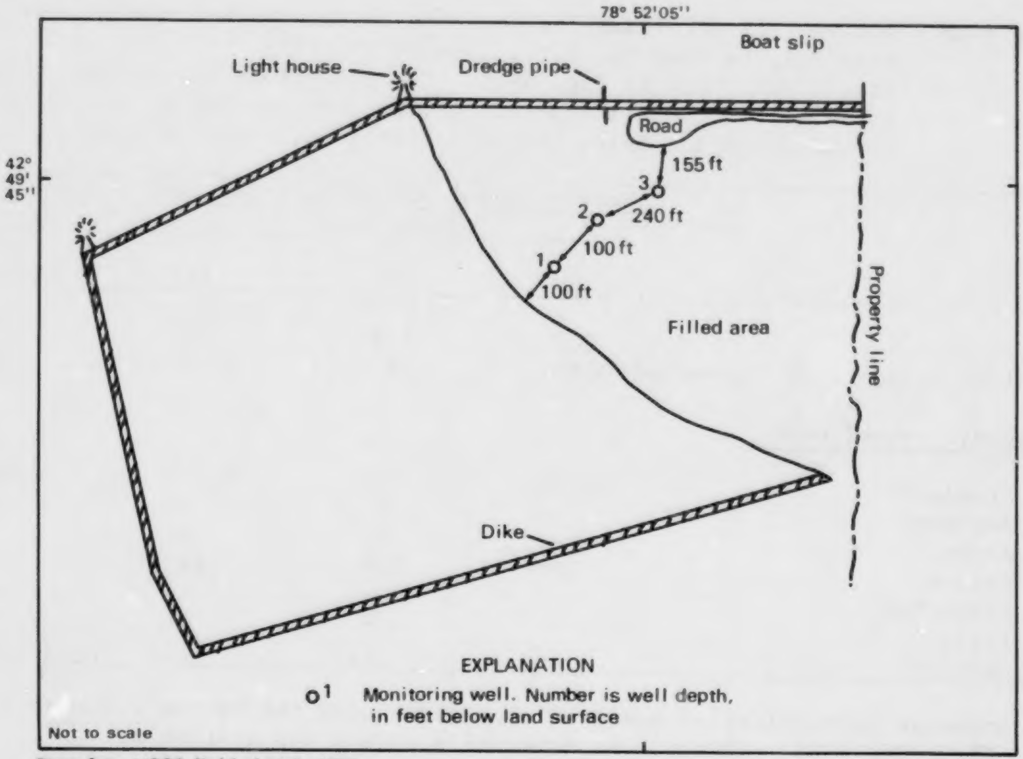
If the barrier here is similar to that at Times Beach containment site (site 241), it would not prevent water from entering or leaving the site, and any leachate produced within the site would readily enter Lake Erie and the Buffalo

Harbor waters. Therefore, this site has a major potential for contaminant migration. Additional monitoring would be needed to define the rate of contaminant migration.

Geologic information.--The dredged sediments on the area consist of sand, silt, and clay. The underlying bedrock is Onondaga Limestone overlain by natural lake deposits of silt and clay.

Hydrologic information.--The U.S. Geological Survey installed three monitoring wells in the area in 1982 (fig. A-25); the well data and geologic logs are given on p. 172. The wells form an east-west line, approximately 100 ft south of the dredge pipe on the east side of the containment area.

Chemical information.--In January 1983, the U.S. Geological Survey sampled the three monitoring wells and the containment pond for USEPA priority pollutant analysis; results are given in table A-28. The samples are dredge spoils and therefore were not compared to State and Federal criteria. The samples contained eight organic priority pollutants, several organic nonpriority pollutants, and one organic compound that may be of natural origin.



Base from USGS field sketch, 1982

Figure A-25. Location of monitoring wells at Buffalo Harbor Containment Site, site 254, on Lake Erie, Lackawanna.

Well no.	Depth (ft)	Description
1	0 - 0.5	Fine sand. Land surface probably less than 2 ft above pond surface.
	0.5 - 4.0	Depth to water surface approximately 1.5 ft below land surface. Entire well augered.
2	0 - 0.5	Fine sand. Land surface less than 4 ft above pond level.
	0.5 - 8.0	Sandy loam. Water surface at 2.5-3.5 ft below land surface. Augered entire well; some slumping.
3	0 - 0.5	Fine sand.
	0.5 - 6.5	Sandy loam.
	6.5 - 8.0	Hard pack (possibly cemented) black, granular material much like fly ash. Saturated at about 8 ft. Well was augered to 8 ft, drove pipe to 12 ft at about 1 ft/hr.

Table A-28.--Analyses of water samples from the Buffalo Harbor Containment Site, site 254, Lackawanna, N.Y., January 10, 1983.
[Locations shown in fig. A-25. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	Ground water			Surface water
	1 (12)	2 (8)	3 (4)	4 (0.5)
pH	11.5	6.2	6.8	4.3
Specific conductance (µmho/cm)	3,000	1,500	1,030	280
Inorganic constituents				
Aluminum	5,630	4,050	5,410	1,680
Antimony	--	--	--	--
Arsenic	--	15†	36†	--
Barium	270†	219†	212†	--
Beryllium	--	--	--	--
Boron	--	--	--	169
Cadmium	--	6.7	12†	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or the New York State standard for maximum concentration in drinking water.

Table A-28.--Analyses of water samples from the Buffalo Harbor Containment Site, site 254, Lackawanna, N.Y., January 10, 1983 (continued)
[Locations shown in fig. A-25. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number			
	Ground water			Surface water
	1	2	3	4
Inorganic constituents (continued)				
Chromium	216†	40	51†	19
Cobalt	--	--	--	--
Copper	--	--	62	--
Iron	39,600†	57,200†	82,500†	7,080†
Lead	128†	120†	125†	72†
Manganese	5,240†	2,550†	7,540†	311†
Mercury	--	--	--	--
Nickel	--	--	--	--
Selenium	--	--	--	--
Silver	--	--	--	--
Thallium	--	--	--	--
Tin	24	--	52	--
Vanadium	--	--	--	--
Zinc	1,200	14,700†	27,900†	124
Organic Compounds				
Priority pollutants				
Benzene	37†	120†	610†	--
Chlorobenzene	11	67	250	--
Toluene	8.3	--	--	--
Fluoranthene	24†	--	--	--
Naphthalene	110	--	--	--
bis(2-ethylhexyl) phthalate	22	LT	38	--
Acenaphthylene	21†	--	--	--
Phenanthrene	24†	--	--	--
Nonpriority pollutants				
o-Xylene	--	LT	5.6	--
Methylcyclopentane[1]	200	--	31	--
3-Methylpentane[1]	28	--	--	--
Hexane[1]	580	--	100	--
4-Methylbenzeneamine[1]	16	--	--	--
2-Naphthaleneamine[1]	17	--	--	--
2,4-Dimethylheptane[1]	--	21	--	--
4-Ethyl-2-methylhexane[1]	--	9.6	--	--
3,5-Dimethylheptane[1]	--	22	--	--
1,3-Dimethylbenzene[1]	--	5.0	--	--
1,2-Dimethylbenzene[1]	--	--	--	5.1
1-(2-Butoxyethoxy)-ethanol[1]	--	230	--	--

APPENDIX B

TONAWANDA AREA SITE DESCRIPTIONS

A total of 60 waste-disposal sites in the Tonawanda area were investigated to determine the potential for contaminant migration. Twenty-nine were sampled by the U.S. Geological Survey during its 1982 test-drilling and sampling program; the remaining 31 were evaluated through a literature review.

Of the 60 sites investigated, 20 were designated as having a major potential for contaminant migration; the remaining 40 were designated as having an indeterminable potential.

The following section describes the location, past and current disposal practices, and potential for contaminant migration at the 33 sites; it also includes the geologic, hydrologic, and chemical data. Site locations are shown on plate 2.

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6. BUFFALO PUMPS DIVISION (USGS reconnaissance) NYSDEC 932044

General information and chemical-migration potential.--The Buffalo Pumps Division site, in the City of North Tonawanda, was used to dispose of an unknown quantity of boiler ash. The site was closed in 1971 and has since been partly covered with grass.

Heavy-metals concentrations in a sediment sample from a wetland at the west end of the property were higher than in water samples from near the refuse area. Additional data would be needed to determine whether migration is taking place; thus, the potential for contaminant migration is indeterminable.

Geologic information.--The site consists of glacial lacustrine clay overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled on the site in 1982; locations are shown in figure B-1. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 6.2	Fill.
	6.2 - 11.2	Clay, tan, wet.
	11.2 - 27.0	Same, but wetter.
	27.0 - 28.5	Clay, sandy, pinkish.
	28.5 - 30.0	Bedrock.
		SAMPLE: 5 - 7 ft.
2	0 - 1.0	Topsoil.
	1.0 - 3.0	Clay, gray.
	3.0 - 5.0	Sand, clayey, dark, very wet.
	5.0 - 5.5	Clay, dry.
	5.5 - 6.2	Sand, dry, tight.
		SAMPLE: 3 - 5 ft.

Hydrologic information.--Water levels in the two wells indicated ground water to be 3 to 5 ft below land surface. The direction of ground-water flow appeared to be toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected water samples from the two wells and a sediment sample from the swamp on the west side of the property (fig. B-1) for chromium, copper, iron, and organic-compound analyses. Results are given in table B-1. No organic compounds were found; however, the sediment sample was analyzed at a detection limit of mg/kg instead of µg/kg. The concentrations of chromium, copper, and iron in the water samples exceeded USEPA criteria for drinking water and the New York State ground-water standards. The substrate sample had a higher copper concentration than soil samples from undisturbed areas.

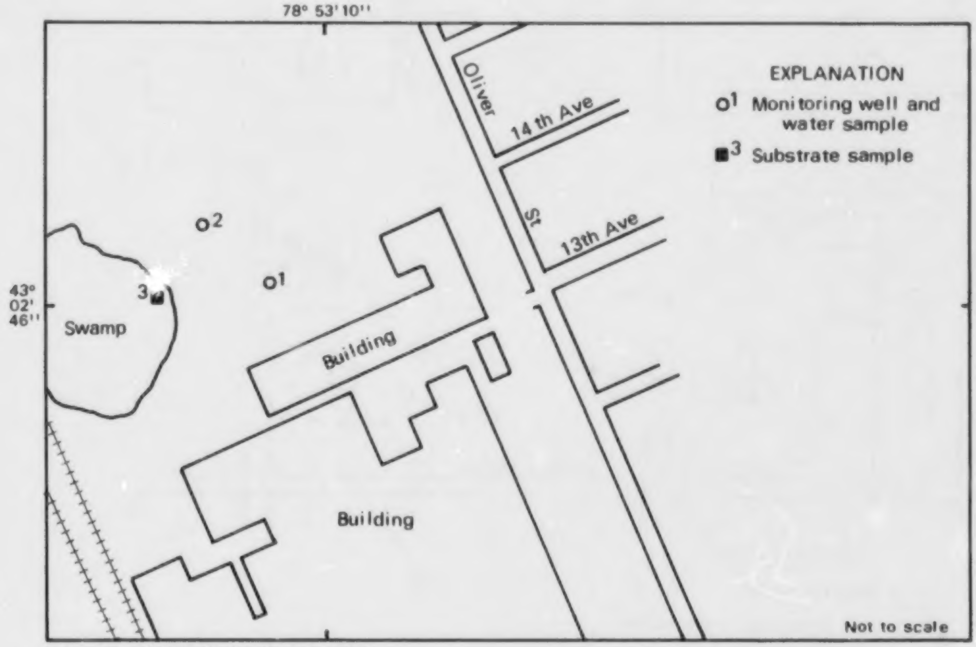
Table B-1.--Analyses of ground-water and sediment samples from Buffalo Pumps Division, site 6, North Tonawanda, N.Y., June 21, 1982. [Locations shown in fig. B-1. Concentrations are in µg/L and µg/kg respectively; dashes indicate that compound was not found.]

	Sample number		
	Ground water		Surface-water sediment
	1	2	3
Inorganic constituents			
Chromium	150†	40	--
Copper	3,400†	300	1,500,000††
Iron	260,000†	51,000†	10,000,000
Organic compounds	--	--	***

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standard for maximum concentration in ground water.

†† Exceeds concentrations in samples from undisturbed soils in the Tonawanda area. Undisturbed soils not analyzed for iron.

*** Analyzed at detection limit above that required by this study. No compounds detected.



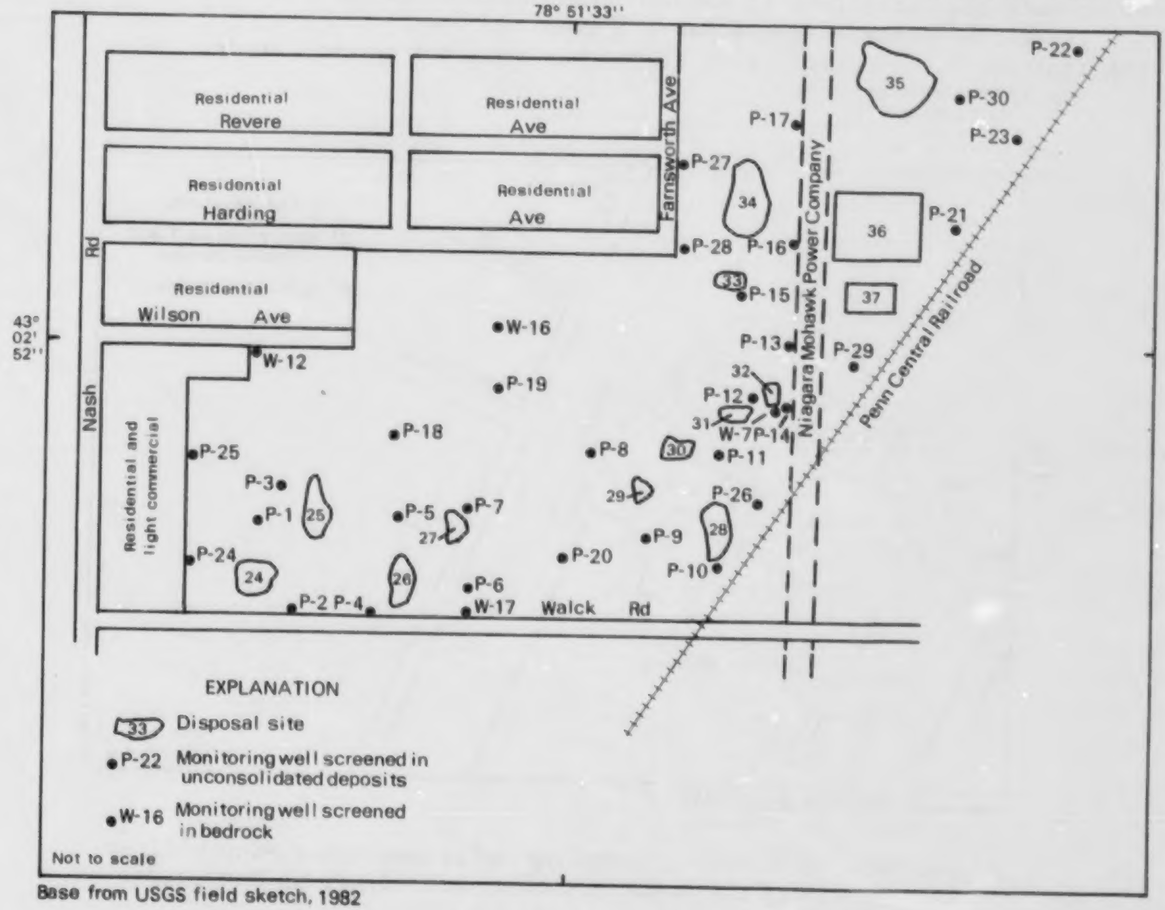
Base from USGS field sketch, 1982

Figure B-1. Location of sampling holes and monitoring well at Buffalo Pumps Division, site 6, North Tonawanda.

24-37. OCCIDENTAL CHEMICAL-DUREZ DIVISION (Literature review) NYSDEC 932018

General information and chemical-migration potential.--The Occidental Chemical-Durez Division, in the city of North Tonawanda, has 14 separate disposal areas, which were operated during 1930-73. Sites 36 and 37 (fig. B-2) have been properly capped with clay and are being monitored by the present owner. The buried materials consist of 250 tons of phenol tar (some may contain chlorobenzenes), 28,000 tons of phenol-bearing material, and 25 tons of calcium-aluminum oxide and calcium phosphate. The site has been under investigation since 1979. A second investigation that was initiated in response to the detection of dioxin was completed in November 1982. In May 1983, 32 additional piezometers were installed, bringing the total number of piezometers to more than 80. The site owner did additional soil and ground-water sampling in July 1983. In addition, New York State has begun a program to delineate the direction of ground-water flow and chemical migration.

The potential for contaminant migration within the permeable fill and fluvial sand and gravel is major. Analyses of the monitoring-well samples indicate that some migration has taken place, although no chlorinated organic contaminants had reached bedrock as of 1980. This would be expected because



Base from USGS field sketch, 1982

Figure B-2. Location of monitoring wells at Occidental Chemical-Durez Division, sites 24 through 37, North Tonawanda. (Modified from Recra Researh, Inc., 1980.)

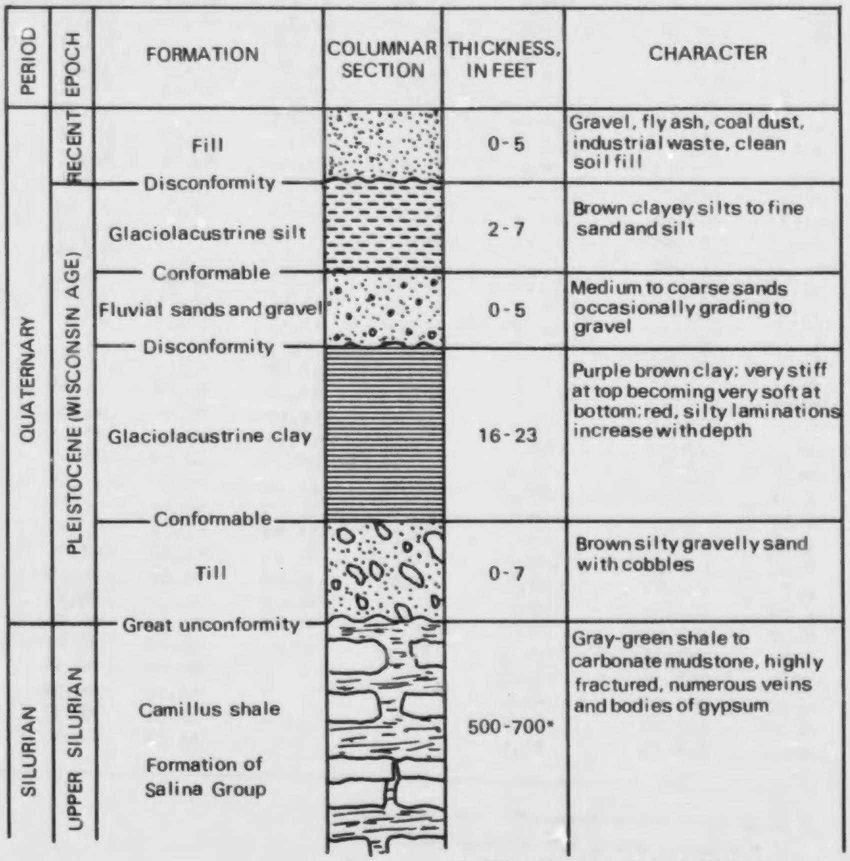
the bedrock is overlain by silt and clay. Offsite migration within ground water has been detected in the southwest corner of the site north of Walck Road, in utility beddings along Walck Road, and perhaps along Wilson Avenue and eastward past the railroad grade (fig. B-2).

Additional chemical data, given in the August 1982 report by Occidental Chemical-Durez, indicate the presence of chemical constituents in the bedrock wells on site. This may have resulted from vertical migration through several old bedrock wells on site that were not properly plugged until 1981 or 1982.

Geologic information.--The site consists of fill overlying glaciolacustrine silt and clay units that are underlain in places by till. These units overlie bedrock of Camillus Shale. A geologic column is shown in figure B-3.

The present owner installed 23 shallow wells during 1979-80 to monitor water levels and collect water samples (fig. B-2). The geologic logs and well-construction specifications are given in Recra Research, Inc. (1980).

Hydrologic information.--The bedrock (Camillus Shale) is estimated to have a transmissivity value ranging from 7,000 to 80,000 (gal/d)/ft. This wide range reflects the varying amount of dissolution cavities, joints, and bedding



PERIOD	EPOCH	FORMATION	COLUMNAR SECTION	THICKNESS, IN FEET	CHARACTER
QUATERNARY	RECENT	Fill		0-5	Gravel, fly ash, coal dust, industrial waste, clean soil fill
		— Disconformity —			
	PLEISTOCENE (WISCONSIN AGE)	Glaciolacustrine silt		2-7	Brown clayey silts to fine sand and silt
		— Conformable —			
		Fluvial sands and gravel		0-5	Medium to coarse sands occasionally grading to gravel
		— Disconformity —			
		Glaciolacustrine clay		16-23	Purple brown clay; very stiff at top becoming very soft at bottom; red, silty laminations increase with depth
		— Conformable —			
		Till		0-7	Brown silty gravelly sand with cobbles
		— Great unconformity —			
SILURIAN	UPPER SILURIAN	Camillus shale Formation of Salina Group		500-700*	Gray-green shale to carbonate mudstone, highly fractured, numerous veins and bodies of gypsum

* Drilling penetrated upper 60 feet

Figure B-3. General geologic column of formations underlying Occidental Chemical-Durez Division, sites 24 through 37, North Tonawanda. (Modified from Recra Research, Inc., 1980.)

planes within the formation. Regionally, under nonpmping conditions, ground water in the Camillus Shale moves west and south to discharge into Tonawanda Creek and Niagara River (Recra Research, Inc., 1980).

The unconsolidated depoists contain a water table, which suggests generally southward flow from most of the site, except where ground-water gradients on the northeast side indicate northeastward flow. These flow patterns are generally restricted to the more permeable material overlying the silt and clay. The permeability of the silt and clay is estimated to be 10^{-6} cm/s.

Table B-2.--Water-table altitudes in wells at Occidental Chemical-Durez, sites 24-37, North Tonawanda, N.Y., 1980[1]
[All altitudes are in reference to site benchmark 2 at 100.08 ft above NGVD. Locations are shown in fig. B-2. Blank space indicates no measurement made.]

Well number[2]	Reference-point altitude (ft)	Land-surface altitude (ft)	Date of measurement				
			1-10-80	1-15-80	2-5-80	4-3-80	6-18-80
P-1	100.58	98.2	95.83	96.08	95.50	96.33	95.75
P-2	100.32	98.3	93.24	93.49	92.65	94.20	93.53
P-3	100.68	98.7	96.43	96.76	96.22	97.18	96.81
P-4	100.20	98.5	93.12	93.17	93.12	93.28	93.12
P-5	100.58	98.7	94.66	95.00	94.58	95.67	94.83
P-6	99.73	97.9	92.73	92.77	92.65	93.34	
P-7	99.66	98.0	93.83	92.99	93.58	94.37	93.99
P-8	102.95	101.0	94.95	95.12	94.49	95.78	95.03
P-9	102.03	99.8	95.86	96.20	95.78	96.70	
P-10	102.60	101.7	95.43	96.02	95.18	96.89	95.23
P-11	103.17	101.4	99.55	99.75	99.71	99.80	99.46
P-12	103.56	101.2	97.19	97.23	97.14	96.89	97.27
P-13	101.94	99.9	97.19	97.77	96.61	98.19	96.94
P-14	103.11	101.0	97.44	98.07	97.11	98.69	97.53
P-15	101.86	99.3	97.11	97.69	96.78	98.19	97.03
P-16	100.10	98.1	97.10	97.35	97.27	97.52	96.27
P-17	100.44	98.4	97.61	98.11	97.27	98.02	96.19
P-18	100.81	99.1	97.14	97.19	97.14	97.48	
P-19	102.72	101.2	93.76	94.10	93.39	95.10	93.80
P-20	101.60	99.8	93.93	94.18	93.68	94.77	
P-21	100.53	98.3	96.74	97.53	96.36	97.45	
P-22	100.21	97.9	96.88	97.21	96.59	97.38	96.09
P-23	101.49	98.7	96.91	97.24	96.45	97.32	
P-24	100.12	98.3	95.91	96.70	95.10	97.75	95.41
P-25	100.64	98.2	96.22	96.93	95.85	97.52	95.31
P-26	101.72	100.5	96.64	96.97	96.47	97.26	96.89
P-27	100.93	98.7	96.93	98.18	96.26	98.88	
P-28	100.92	99.2	96.75	98.09	96.21	98.21	96.05
P-29	101.83	98.4	96.66	97.83	96.37	97.91	
P-30	102.11	100.1	97.19	97.61	96.61	97.61	
W-7	103.34	100.0			88.76	88.34	88.01
W-12	101.63	98.6			88.55	88.59	87.92
W-16	102.85	97.9			88.85	88.35	87.52
W-17	100.23	98.1			88.48	88.40	88.31

[1] Data from Recra Research, Inc. (1980)

[2] P = shallow well, W = bedrock well

Chemical information.--Recra Research sampled several of the monitoring wells for selected organic compounds; results are given in table B-3. Water from the shallow wells contained a substantial amount of contamination from the overburden; the bedrock wells did not indicate chlorinated organic compounds in 1980.

Source of data.--Recra Research, Inc., 1980, Hydrogeologic investigation, Durez Division, Hooker Chemicals and Plastics Corporation, Walck Road, North Tonawanda, Niagara County, New York: City of Buffalo, 74 p., 10 figs., 11 append.

Table B-3.--Analyses of samples from monitoring wells at Occidental Chemical-Durez, sites 24-37, North Tonawanda, N.Y., 1980[1]
[Well locations are shown in fig. B-2. Concentrations are in µg/L. Dashes indicate not analyzed, ND indicates not detected.]

Constituent	Well number and date sampled (P = shallow well)							
	P-1 4-4-80	P-1 6-18-80	P-2 4-4-80	P-2 6-17-80	P-3 4-4-80	P-3 6-17-80	P-4 4-2-80	P-4 6-18-80
pH (Field)	--	--	--	--	--	--	--	6.75
pH (Lab)	8.90	7.68	--	7.44	9.80	7.99	7.02	7.76
Specific conductance (µmho/cm)	1,290	970	--	2,080	2,010	2,810	1,310	1,380
Total recoverable phenolics	4.3	2.3	0.023	0.015	0.49	0.71	0.22	0.025
Toluene	80	290	ND	ND	ND	ND	ND	ND
Monochloroenzene	ND	85	ND	ND	--	1,400,000	ND	940
O-dichlorobenzene	190	160	22	13	2,600	1,500	2,300	3,200
M-dichlorobenzene	32	62	ND	ND	780	350	770	2,000
P-dichlorobenzene	170	280	29	18	2,200	1,800	1,400	5,000
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND	ND	370	200
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND	ND	680	1,100
1,3,5-trichlorobenzene	ND	23	ND	ND	ND	ND	27	46

Constituent	P-5 4-2-80	P-5 6-18-80	P-7 4-4-80	P-7 6-17-80	P-8 4-4-80	P-9 4-1-80	P-10 4-4-80	P-10 6-17-80
pH (Field)	--	--	--	7.45	--	--	--	6.90
pH (Lab)	12.46	12.37	7.61	7.81	--	6.91	7.68	7.68
Specific conductance (µmho/cm)	8,410	7,450	3,640	2,250	--	5,100	936	870
Total recoverable phenolics	0.34	0.62	190	44	0.024	0.21	0.022	0.018
Toluene	98	89	190	680	ND	ND	ND	ND
Monochloroenzene	--	4,000	ND	12,000	ND	ND	ND	ND
O-dichlorobenzene	2,300	430	1,000	3,200	ND	ND	ND	ND
M-dichlorobenzene	330	52	200	1,100	ND	ND	ND	ND
P-dichlorobenzene	1,500	350	1,300	5,500	ND	ND	ND	ND
1,2,3-trichlorobenzene	ND	ND	33	ND	ND	ND	ND	ND
1,2,4-trichlorobenzene	ND	20	34	910	ND	ND	ND	ND
1,3,5-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND

Constituent	P-11 4-1-80	P-11 6-17-80	P-12 4-2-80	P-12 6-18-80	P-13 4-2-80	P-14 4-2-80	P-14 6-18-80	P-15 4-2-80
pH (Field)	--	6.60	--	6.75	--	--	11.90	--
pH (Lab)	8.27	7.87	7.32	7.49	7.47	12.34	12.04	7.69
Specific conductance (µmho/cm)	679	452	2,900	1,810	1,180	5,620	3,720	4,800
Total recoverable phenolics	64	190	1.1	29	0.021	0.098	0.058	0.13
Toluene	480	1,100	180	ND	ND	ND	ND	ND
Monochloroenzene	ND	460	ND	1,300	ND	ND	ND	ND
O-dichlorobenzene	17	76	54	ND	ND	ND	ND	ND
M-dichlorobenzene	16	ND	21	ND	29	ND	ND	58
P-dichlorobenzene	25	26	170	ND	18	12	ND	25
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	25
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND

Table B-3.--Analyses of samples from monitoring wells at Occidental Chemical-Durez, sites 24-37, North Tonawanda, N.Y., 1980[1] (continued)

	Well number and date sampled (P = shallow well; W = deep well)							
Constituent	P-15 6-18-80	P-16 4-2-80	P-17 4-2-80	P-19 4-4-80	P-19 6-18-80	P-20 4-2-80	P-21 4-2-80	P-22 4-2-80
pH (Field)	6.75	--	--	--	6.50	--	--	--
pH (Lab)	7.36	12.57	12.49	7.14	7.19	7.73	7.41	8.23
Specific conductance (µmho/cm)	4,890	10,300	8,640	7,200	5,700	1,770	1,710	1,220
Total recoverable phenolics	0.48	0.049	0.013	0.065	0.207	0.037	0.028	0.047
Toluene	110	ND	ND	ND	ND	ND	ND	ND
Monochloroenzene	160	ND	ND	ND	ND	ND	ND	ND
O-dichlorobenzene	ND	ND	ND	ND	46	37	52	ND
M-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
P-dichlorobenzene	ND	ND	11	ND	14	25	17	ND
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND

Constituent	P-22 6-17-80	P-23 4-2-80	P-24 4-1-80	P-24 6-17-80	P-25 4-4-80	P-25 6-17-80	P-26 4-4-80	P-26 6-17-80
pH (Field)	6.80	--	--	6.95	--	7.00	--	6.95
pH (Lab)	7.49	7.71	7.17	7.48	7.42	7.39	6.46	7.75
Specific conductance (µmho/cm)	1,510	1,240	780	765	1,270	890	1,640	1,070
Total recoverable phenolics	0.031	0.016	1.0	0.11	ND	0.02	23	5.1
Toluene	ND	ND	ND	ND	ND	ND	2,400	3,300
Monochloroenzene	ND	ND	ND	ND	ND	ND	--	1,200
O-dichlorobenzene	ND	ND	ND	ND	ND	ND	13	15
M-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
P-dichlorobenzene	ND	ND	ND	ND	ND	ND	12	15
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND

Constituent	P-27 4-2-80	P-28 4-2-80	P-28 6-18-80	P-29 4-2-80	P-30 4-2-80	W-7 4-3-80	W-7 6-12-80	W-12 4-3-80
pH (Field)	--	--	6.85	--	--	--	--	--
pH (Lab)	6.96	7.73	7.49	7.37	7.55	7.28	7.71	--
Specific conductance (µmho/cm)	1,600	1,470	1,210	965	1,870	4,120	3,970	--
Total recoverable phenolics	0.014	0.014	0.002	0.042	0.023	0.018	0.075	0.060
Toluene	ND	ND	ND	ND	ND	ND	240	ND
Monochloroenzene	ND	ND	ND	ND	ND	ND	ND	ND
O-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
M-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
P-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND

Constituent	W-12 6-12-80	W-16 4-3-80	W-16 6-12-80	W-17 4-3-80	W-17 6-12-80
pH (Field)	--	--	--	--	--
pH (Lab)	7.63	7.14	7.36	6.98	7.34
Specific conductance (µmho/cm)	3,720	4,300	4,110	13,400	10,900
Total recoverable phenolics	11	19	ND	ND	ND
Toluene	ND	ND	ND	ND	ND
Monochloroenzene	ND	ND	ND	ND	ND
O-dichlorobenzene	ND	ND	ND	ND	ND
M-dichlorobenzene	ND	ND	ND	ND	ND
P-dichlorobenzene	ND	ND	ND	ND	ND
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND
1,3,5-trichlorobenzene	ND	ND	ND	ND	ND

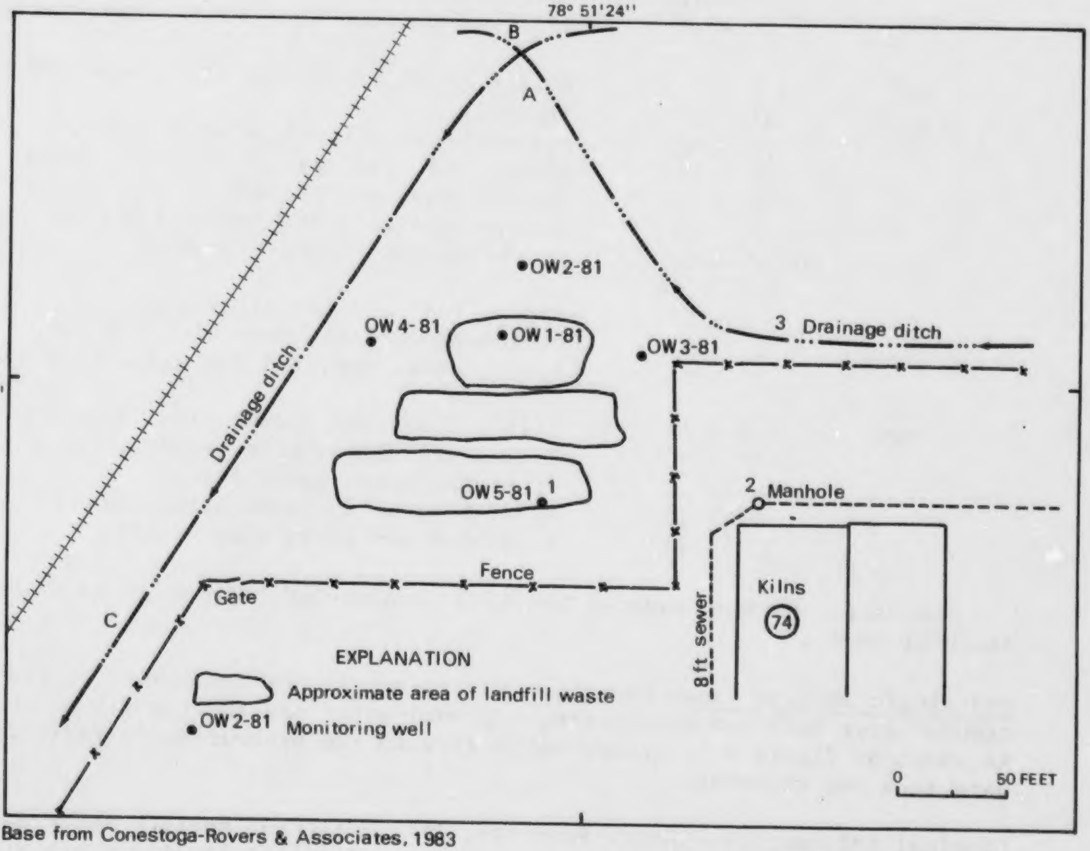
Data from Recra Research, Inc., 1980.

50. NATIONAL GRINDING WHEEL (Literature review) NYSDEC 932066

General information and chemical-migration potential.--National Grinding Wheel Division of Federal-Mogul Corporation, is on Walck Road in North Tonawanda. During 1974-77, the company disposed of waste in an undeveloped area northwest of the plant. A sketch of the site showing sampling points is given in figure B-4.

The landfilling operations took place in three trenches covering an area of about 100 ft^2 and extending to a maximum depth of 18 ft. The waste material consisted of unknown quantities of vitrified bakelite wheels, rubber resinoid mix, dust-collector fines, and general refuse. Disposal ceased during 1977 when National Grinding Wheel withdrew its application for a permit to operate a landfill at this location.

After completion of a hydrogeologic investigation of the site (NYSDEC, written commun., 1983), National Grinding Wheel proposed to remediate the site by excavating the disposal trenches. Remediation began in July 1983 and, except for final grading, was completed in September. Salvageable grinding



Base from Conestoga-Rovers & Associates, 1983

Figure B-4. Location of monitoring wells and surface-water samples at National Grinding Wheel, site 50, North Tonawanda.

wheels were reclaimed, and contaminated soil and nonreclaimable wheels were sent to a sanitary landfill for disposal. The excavated area was backfilled with clean material.

The present potential for offsite contaminant migration is indeterminable.

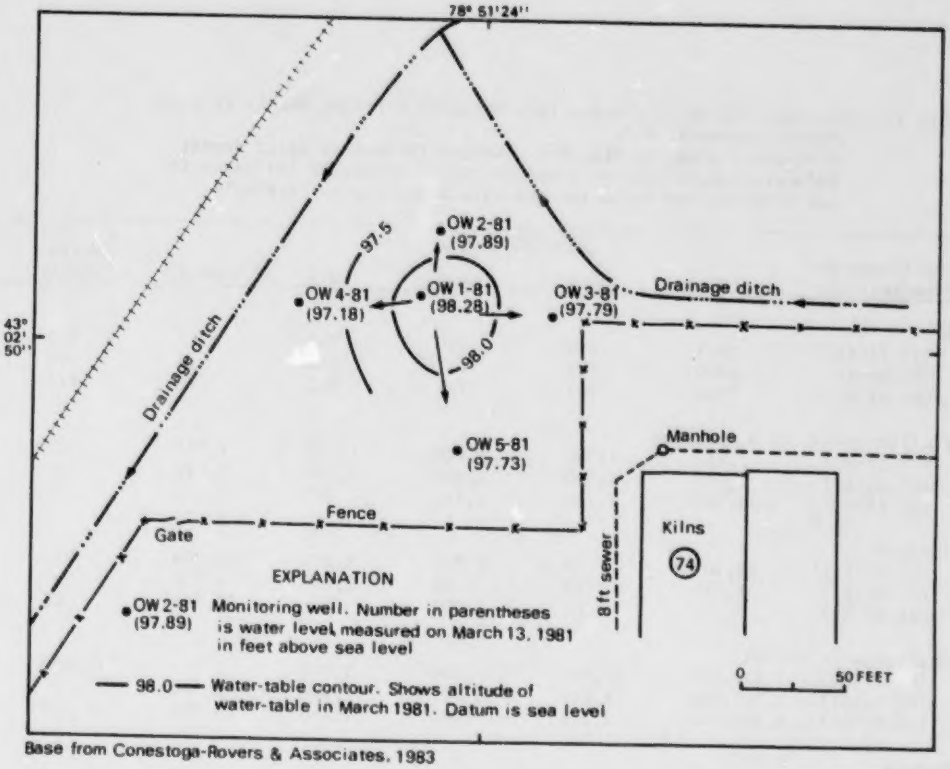
Geologic information.--In January 1981, Empire Soils installed five monitoring wells; locations are shown in figure B-5. Well depths range between 5 and 10 ft. The geologic logs are as follows:

Well no.	Depth	Description
OW1	0 - 1'	Brownish red silt and clay cover mottled.
	1' - 10.5'	Fill - grinding wheels, stone, glass, plastic - reddish black oily liquid.
	10.5' - 14'	Medium-brown silty clay - soft.
OW2	0 - 1'	Topsoil.
	1' - 2'	Brown and orange silty fine sand.
	2' - 5'	Medium-brown silty fine sand, wet at 4 ft.
	5' - 8.5'	Red, brown, and gray silty clay layers - stiff.
	8.5' - 10'	Reddish-brown and gray silty clay - stiff.
OW3	0 - 1.5'	Fill - brown and orange silt, sand and clay.
	1.5' - 2'	Topsoil.
	2' - 5'	Medium-brown silty fine sand - wet.
	5' - 8'	Brown, red, and gray silty clay layers.
	8' - 13'	Medium-brown silty clay.
	13' - 20.5'	Medium- and reddish-brown silty clay - soft.
	20.5' - 21'	Reddish-brown clayey silt till.
OW4	0 - 2'	Brown, red, and tan silty clay.
	2' - 5'	Medium-brown fine sandy silt - moist.
	5' - 9'	Brown, gray, red, and tan silty clay layers.
OW5	0 - 3'	Fill - brown and orange clay, silt and fine sand.
	3' - 7'	Fill - grinding wheels, stones, few chuncks of medium-brown sandy silt.
	7' - 12'	Reddish-brown and gray silty clay.
	12' - 14'	Reddish-brown silty clay - soft.

Foundation borings made on the site encountered bedrock at an average depth of 38 ft.

Hydrologic information.--Conestoga Rovers and Associates (1982) collected ground-water data and constructed a ground-water map showing flow direction. As shown on figure B-5, ground-water flow in the overburden is radially outward from the trenches.

Chemical information.--Recra Research, Inc. collected surface-water and ground-water samples for chemical analysis. Sampling locations are shown on figure B-4. Most samples were analyzed for pH, total organic carbon, specific conductance, and phenols. Results are given in tables B-4 and B-5.


78° 51'24''
43° 02' 50''
Drainage ditch
Drainage ditch
97.5
OW 2-81 (97.89)
OW 4-81 (97.18)
OW 1-81 (98.28)
OW 3-81 (97.79)
98.0
OW 5-81 (97.73)
Manhole
Fence
Gate
Kilns
74
8 ft sewer
EXPLANATION
OW 2-81 (97.89) Monitoring well. Number in parentheses is water level measured on March 13, 1981 in feet above sea level
98.0 Water-table contour. Shows altitude of water-table in March 1981. Datum is sea level
0
50 FEET

Base from Conestoga-Rovers & Associates, 1983

Figure B-5. Direction of ground-water flow at National Grinding Wheel, site 50, North Tonawanda, N.Y. (Modified from Conestoga-Rovers and Associates, 1982.)

Table B-4.--Analyses of surface-water samples from National Grinding Wheel, site 50, North Tonawanda, N.Y. April 6, 1979. [Concentrations in μg/L; LT indicates constituent or compound was detected but below the quantifiable detection limit.][1]

	Sample identification		
	A	B	C
Specific conductance (umho/cm)	472	700	489
Aluminum, soluble	800	800	1,000
Chloride	17,500	95,200	36,500
Chromium, soluble	8	LT	4
Copper, soluble	1,660	480	34
Iron, soluble	180	210	220
Nickel, soluble	40	LT	LT
Zinc, soluble	45	78	29
Grease and oil, total	LT	LT	LT
Grease and oil, hydrocarbon	LT	LT	LT
Grease and oil, polar	LT	LT	LT
Phenol	780	1,400	100
Total organic carbon	29,500	43,500	44,500

[1] Data from Recra Research, Inc., 1979

Table B-5.--Analyses of water samples from National Grinding Wheel, site 50, North Tonawanda, N.Y.
[Locations shown in fig. B-4. Concentrations in μg/L; dashes indicate constituent or compound not analyzed, LT indicates it was detected but below the quantifiable detection limit.][1]

Constituent or characteristic	Sampling site						
	OW-1	OW-2	OW-3	OW-4	OW-5	North ditch	Sewer manhole
pH							
(02-17-81)	10.1	7.3	7.0	7.3	7.3	7.0	--
(03-04-81)	10.0	6.8	6.7	6.8	6.7	--	--
(06-03-82)	10.0	7.5	7.9	8.2	7.8	7.6	8.7
Specific conductance (umho/cm)							
(02-17-81)	7,660	1,740	1,800	1,610	1,320	423	--
(03-04-81)	7,020	1,500	1,600	1,450	1,140	--	--
(06-03-82)	8,500	1,670	1,348	735	1,120	--	1,500
Aluminum							
(02-17-81)	14,500	50	1,750	1,600	70,000	500	--
(03-04-81)	6,750	LT	LT	3,350	1,350	--	--
(06-03-82)	5,670	LT	1,000	--	15,360	LT	250
Total organic carbon							
(02-17-81)	5,300,000	43,300	21,100	5,000	5,100	15,800	--
(03-04-81)	5,740,000	4,600	19,300	17,100	6,800	--	--
(06-03-82)	8,328,000	7,270	172,000	7,250	19,750	50,380	90,080
Phenols							
(02-17-81)	952,000	18	1,680	11	13	5	--
(03-04-81)	1,150,000	6	1,040	28	11	--	--
(06-03-82)	1,007,000	6	40	100	10	--	100

[1] Data from Recra Research, Inc., 1982

60. ROBLIN STEEL COMPANY (Literature review)

NYSDEC 932059

General information and chemical-migration potential.--The Roblin Steel Company site, in the city of North Tonawanda, contains an unknown quantity of phosphate sludge, steel scale, furnace brick, oil, and oxides. The phosphate sludge is concentrated, compacted, and covered for secure landfilling; the remaining materials are stored in an area of about 1 acre and are being transported periodically to other landfills.

No geologic or hydrologic information are available. The potential for contaminant migration is indeterminable.

67. FRONTIER CHEMICAL COMPANY--PENDLETON SITE NYSDEC 932043
(USGS field reconnaissance)

General information and chemical migration potential.--The Frontier Chemical Company-Pendleton Site, in the town of Pendleton, was used for treatment of industrial wastes. An unknown quantity of waste oil, solvent, acids, paint waste, dyes, heavy-metal sludges, and other material was disposed of on the site. A quarry lake on the property that was used in the treatment operations is contaminated with heavy metals. A remedial program is being implemented that consists of treating and dewatering the lake and excavating the sludge, which will be contained in a secure facility to be built on the property.

The potential for downward migration through the clay beneath the site appears limited, but the chemical data suggest that a small quantity of heavy metals may be leaching laterally, as indicated by surface-water sample 5 (table B-6). Additional testing would be needed to confirm the migration of contaminants. Currently the potential for contamination migration is indeterminable.

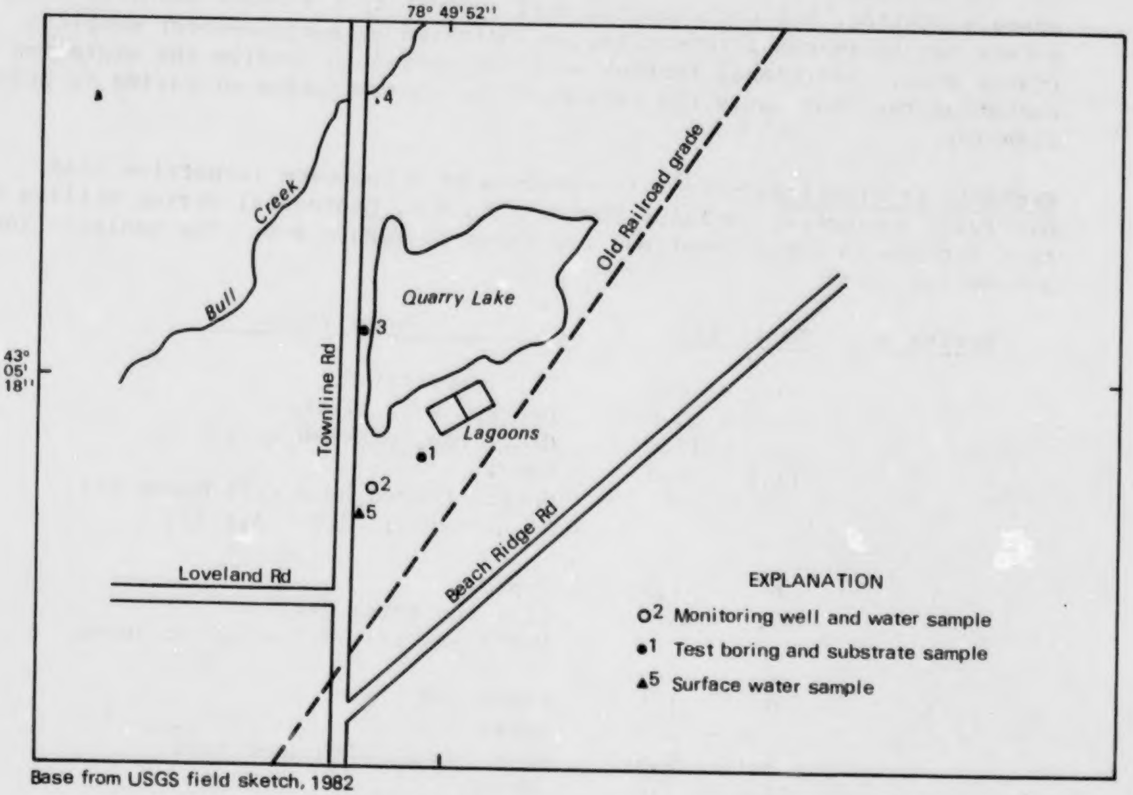
Geologic information.--The site consists of a Holocene lacustrine clay overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled three test borings in 1982; locations are shown in figure B-6. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 4.5	Fill material.
	4.5 - 5.0	Debris, wet, black.
	5.0 - 11.4	Clay, tan, pinkish at 9.0 ft.
	11.4 - 26.5	Same.
		Note: Logged hole with Gamma ray.
		SOIL SAMPLE: 3.0 - 3.5 ft.
2	0 - 1.3	Topsoil
	1.3 - 3.0	Clay and brick debris.
		WATER SAMPLE: 2.5 - 3.0 ft zone.
3	0 - 1.4	Clay, tan
	1.4 - 2.1	Same.
	2.1 - 2.6	Clay, damp, with some sand
	2.6 - 3.4	Same.
	3.1 - 3.6	Clay, pink.
	3.6 - 4.0	Clay, with some quartz sand.
	4.0 - 4.6	Clay, brown, tight
		SOIL SAMPLE: 3.6 - 4.0 ft.

Hydrologic information.--Ground water was encountered 2 to 5 ft below land surface. The U.S. Geological Survey installed one well on the property, in which the water level was slightly higher than in the quarry lake, which was 573 ft above NGVD.

Chemical information.--The U.S. Geological Survey collected five samples in 1982--a water sample from the well, two soil samples from the test borings, and two surface-water samples from the drainage ditch along Townline Road (fig. B-6) for cadmium, chromium, copper, iron, nickel, and zinc analyses. In May 1983, the Survey collected two substrate samples for organic-compound analyses. Results are given in table B-6. The water samples contained iron concentrations that exceeded USEPA criteria for drinking water and New York State standards for ground water; the soil samples had high concentrations of copper.

Additional data on chemical quality of lake water and sediments are available at the NYSDEC office in Buffalo, N.Y.



Base from USGS field sketch, 1982

Figure B-6. Locations of sampling holes and monitoring wells at Frontier Chemical Company, site 67, Pendleton.

Table B-6.--Analyses of ground-water, surface-water, and substrate samples from Frontier Chemical, site 67, Pendleton, N.Y.
[Locations shown in fig. B-6. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit. Blank space indicates that samples were not analyzed for characteristic.]

	Sample number and depth below land surface (ft)					
	Substrate	Ground water		Substrate	Surface water	
First sampling (06-22-82)	1 (3.2)	2 (2.8)	(duplicate)	3 (3.8)	4	5
pH		7.0			7.2	7.4
Specific conductance (μmho/cm)		2,190			2,020	1,970
Temperature (°C)		13.0			26.0	20.0
Inorganic constituents						
Cadmium	--	2	(2)	1,000	2	4
Chromium	5,000	--	(--)	10,000	--	--
Copper	74,000††	18	(15)	150,000††	24	670
Iron	6,000,000	3,000†	(1,400†)	9,500,000	34,000†	200,000†
Nickel	--	53	(57)	20,000	38	1,000
Zinc	26,000	1,700	(1,300)	39,000	180	3,600

	Sample number and depth below land surface (ft)	
	Substrate	
Second sampling (05-23-83)	1A (3.2)	3A (3.8)
Organic compounds		
Priority pollutants		
Trans-1,3,-dichloroethene	110	--
Trichloroethene	900	--
Di-n-butyl phthalate	LT	--

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standard for maximum concentration in ground water.

†† Exceeds concentrations in samples from undisturbed soils in the area. Undisturbed soils not analyzed for iron.

68. GRATWICK-RIVERSIDE PARK (USGS field reconnaissance) NYSDEC 932060

General information and chemical-migration potential.--Gratwick-Riverside Park, in the City of North Tonawanda, was used by two large manufacturing firms for the disposal of 25,000 tons of phenolic resin, 25,000 tons of phenolic molding compounds, 50 tons of oil and grease, and 50,000 tons of municipal rubbish and hard fill. In 1982, the owner removed more than 30 barrels of hazardous waste from the bank of the Niagara River.

The potential for contaminant migration is major. The fill is permeable, enabling ground water to move laterally toward the Niagara River, which is adjacent to the site. Downward movement of contaminants through the underlying clay is unlikely, however.

Geologic information.--The site consists of fill overlying a Holocene lacustrine clay, which in turn overlies bedrock of Camillus Shale. Depth to bedrock is approximately 25 ft. The U.S. Geological Survey drilled one well and obtained a test boring on the site in 1982; its location is shown in figure B-7. The geologic log is as follows:

Depth (ft)	Description
0 - 4.5	Topsoil, fill, dark.
4.5 - 5.5	Debris, pottery, tile.
5.5 - 9.0	Soil, dark, black, wet.
9.0 - 11.5	Gravel, little or no return, bricks.
11.5 - 16.0	No return.
16.0 - 21.5	Clay, sandy, gravel, wet, hard drilling.

Hydrologic information.--Water levels in the newly installed well (no. 1) and four older wells (nos. 2-5) indicate ground water to be approximately 6 ft below land surface. The apparent direction of ground-water flow is southwestward toward the Niagara River.

Chemical information.--In 1979, Recra Research, Inc. completed an investigation of the site. The analytical data and drilling logs are available at NYSDEC in Buffalo, N.Y.

In 1981, the Niagara County Health Department sampled wells 2 through 5 (fig. B-7) for cadmium, chromium, lead, mercury, nickel, total organic halogens, and phenol. Concentrations of all heavy metals were less than or equal to their detection limits. Total organic halogen concentration ranged from less than 1 μg/L to 35 μg/L, and phenol ranged from 200 μg/L to 17,000 μg/L.

In 1982, the U.S. Geological Survey sampled the new monitoring well (no. 1) along with the four others for arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and organic compounds. Results are given in table B-7. All wells except no. 5 had iron and lead concentrations exceeding USEPA drinking-water criteria and New York State ground-water standards. In wells 3, 4, 5, phenols exceeded the USEPA criterion and State standard, and at well 4, phenol was found in concentrations as high as 1,914 ug/L. Concentrations of most other compounds were less than 100 ug/L.

Table B-7.--Analyses of ground-water samples from Gratwick Riverside Park, site 68, North Tonawanda, N.Y., July 28, 1982.
[Locations shown in fig. B-7. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)				
	1 (15.3)	2 (15.0)	3 (11.7)	4 (19.4)	5 (19.2)
pH	11.4	10.6	10.8	10.0	11.2
Specific conductance (µmho/cm)	2,110	1,650	2,450	504	1,780
Temperature (°C)	10.0	12.0	12.0	13.0	13.0
Inorganic constituents					
Arsenic	1	10	1	1	1
Cadmium	3	1	--	1	--
Chromium	3	--	--	--	--
Copper	56	25	12	22	10
Iron	8,800†	6,400†	4,400†	15,000†	3,100†
Lead	100†	150†	64†	140†	43
Mercury	0.7†	--	--	0.1†	0.7†
Nickel	--	5	3	20	5
Molecular sulfur[1]	--	--	--	--	546
Organic compounds					
Priority pollutants					
Phenol	--	--	97†	1,900†	13.7†
Naphthalene	--	--	--	50.3	--
Butylbenzyl phthalate	--	--	--	20.9	--
2,4-Dimethylphenol	--	--	5	--	--
Di-n-butyl phthalate	LT	--	--	--	--
Bis-2(ethylhexyl) phthalate	8**	--	--	--	--
Tetrachloroeylene	--	--	LT†	--	--
Ethylbenzene	--	--	6	--	--
Nonpriority pollutants					
1-(2-butoxyethoxy) ethanol[1]	85**	--	--	--	--
[1-1'-biphenyl]-2-ol[1]	32**	--	LT	5.2	LT

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standard for maximum concentration in ground water.

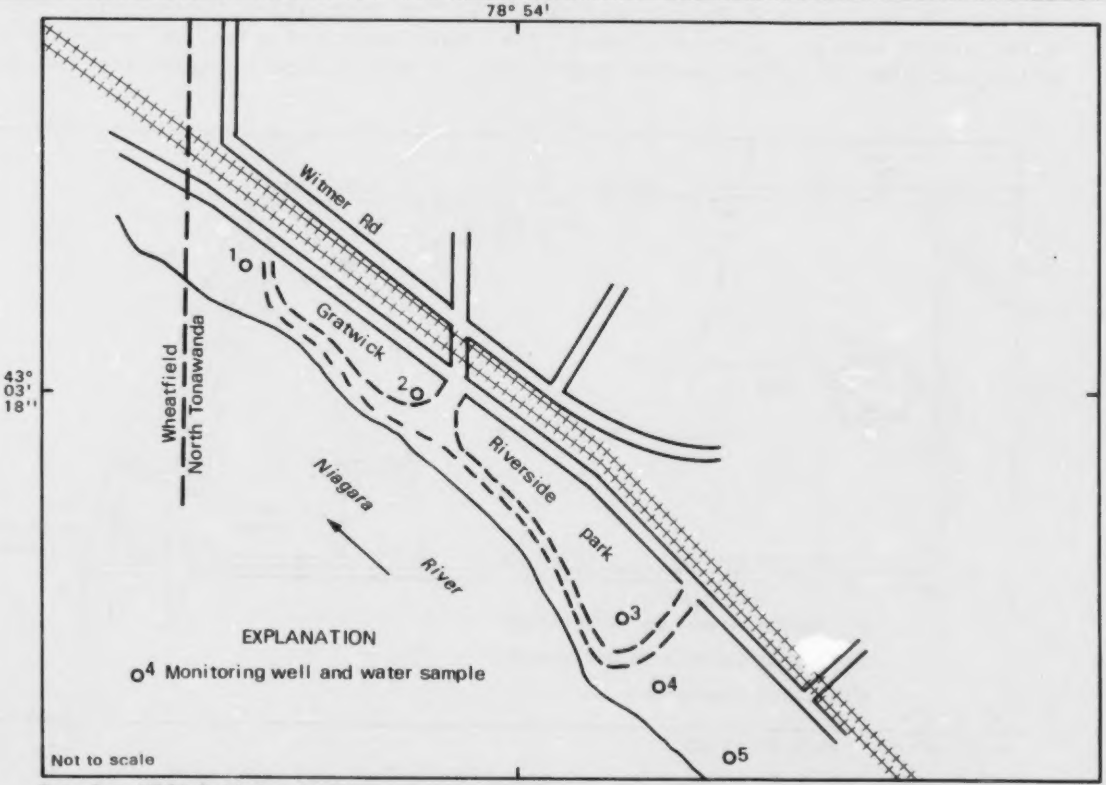
** Surrogate recoveries were outside the acceptance limits.

Table B-7.--Analyses of ground-water samples from Gratwick Riverside Park, site 68, North Tonawanda, N.Y., July 28, 1982 (continued)

	Sample number				
	1	2	3	4	5
Organic compounds (continued)					
Nonpriority pollutants (continued)					
[1-1'-biphenyl]-3-ol[1]	11**	53**	--	--	--
[1-1'-biphenyl]-4-ol[1]	5.2**	35**	--	5.0	--
2-dibenzofuranol[1]	8.8**	15**	--	--	--
1-chloro-3-phenoxybenzene[1]	--	LT**	--	--	--
4-chloro[1,1'-biphenyl]-4-ol[1]	--	LT**	--	--	--
1-chloro-4-phenoxybenzene[1]	--	LT**	--	--	--
O-cresol	--	--	--	LT	--
3-(1,1-dimethylethyl)-phenol[1]	--	--	--	31.2	--
1-H-indole[1]	--	--	--	LT	--
1,6-dimethyl-4-(1-methylethyl) naphthalene[1]	--	--	--	LT	--
2-[(4-hydroxyphenyl)methyl] phenol[1]	--	--	--	LT	--
4,4'-methylenebisphenol[1]	--	--	--	LT	--
m-cresol	--	--	370	--	194
1,1'-(1,2-ethanediyl)bis [3,4-dimethyl]benzene[1]	LT**	--	--	--	--
2-butoxyethylbutyl phthalate[1]	7.4**	--	--	--	--
1,6-hexanediol[1]	--	LT**	--	--	--
1-1'-oxybisbenzene[1]	--	6.2**	--	--	--
1-(1,1'-dimethylethyl) benzene[1]	--	LT**	--	--	--
3,8-dimethylundeeane[1]	--	2.5**	--	--	--
Dibenzofuran[1]	--	3.2**	--	--	--
[1-1'-biphenyl]-2-ol[1]	--	44**	--	--	--
2-phenoxyphenol[1]	--	4.8**	--	--	--
3-ethyl-3-methyl hexane[1]	--	1.3**	--	--	--
4-phenoxylphenol[1]	--	16**	--	--	--
4-(1,1-Dimethylethyl)-phenol[1]	--	--	--	--	14.7
1,4-Dimethyl-7-(1-methylethyl) azulene[1]	--	--	--	--	LT
1,2-Dimethylbenzene[1]	--	--	LT	--	--
1,3-Dimethylbenzene[1]	--	--	LT	--	--
1-Ethyl-3-methylbenzene[1]	--	--	LT	--	--
1-Ethyl-4-methylbenzene[1]	--	--	LT	--	--
1,2,3-Trimethylbenzene[1]	--	--	5	--	--
P-cresol	--	--	18	--	--
1-Ethyl-2-methylbenzene[1]	--	--	LT	--	--

Table B-7.--Analyses of ground-water samples from Gratwick Riverside Park, site 68, North Tonawanda, N.Y., July 28, 1982 (continued)

	Sample number				
	1	2	3	4	5
Organic compounds (continued)					
Nonpriority pollutants (continued)					
Dihydro-5-methyl-5-phenyl 2(3H)-furanone [1]	--	--	LT	--	--
a,a,-Dimethylbenzene-methanol [1]	--	--	LT	--	--
1,2,3,4-Tetramethylbenzene[1]	--	--	LT	--	--
3,4-Dimethylphenol[1]	--	--	15	--	--
2,3-Dihydro-4-methyl 4-indene [1]	--	--	LT	--	--
2-Ethylphenol	--	--	LT	--	--
2,3-Dimethylphenol[1]	--	--	LT	--	--
2-[2-(2-Butoxyethoxy) ethoxy]ethanol [1]	--	--	LT	--	--
1,4-Dihydro-1,4-methano-naphthalene [1]	--	--	LT	--	--
5-(1,1-Dimethylethyl-butanethioate [1]	--	--	LT	--	--
1-Methylnaphthalene[1]	--	--	LT	--	--



Base from USGS field sketch, 1982

Figure B-7. Location of monitoring wells at Gratwick-Riverside Park, site 68, North Tonawanda.

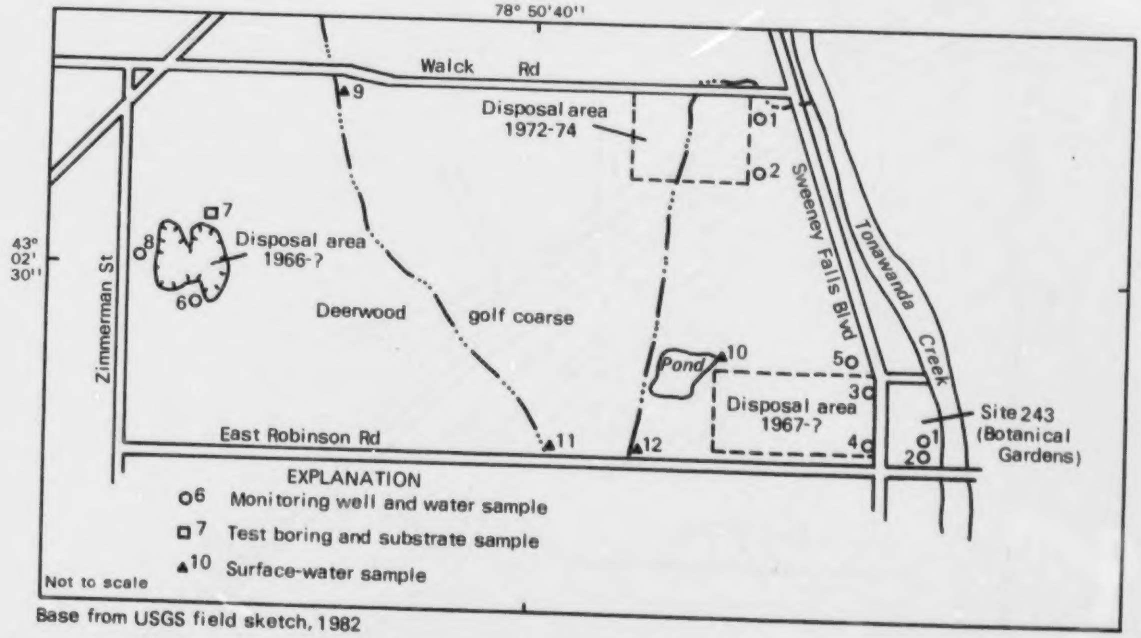
72. HOLIDAY PARK (USGS field reconnaissance)

General information and chemical-migration potential.--The Holiday Park site, in the city of North Tonawanda, was used primarily for municipal-waste disposal and by a chemical firm to dispose of 125 tons of pheolic resin, 500 tons of phenolic molding compounds, and 500 tons of mixed refuse. The materials were buried in three areas on the property and in much of the area now occupied by the golf course.

Chemical data indicate a possiblity of leachate migration from two of the areas. Two samples suggest possible northward migration from the southeast disposal area, and one indicates possible migration from the westernmost area. The presence of organic compounds in one sample is attributed to sampling within the disposal area, as indicated by the drilling log, and cannot be considered evidence of contaminant migration. Additional testing would be needed to confirm migration. The potential for contaminant migration at this site is indeterminable.

Geologic information.--The area consists of glacial lacustrine clay overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled six test borings on the site in 1982; the locations are shown in figure B-8. The geologic logs are on p. 195.

Hydrologic information.--Seven monitoring wells are on the site--five new wells installed by the U.S. Geological Survey in 1982 for this study and two older ones. Water levels in the wells suggest the direction of ground-water flow to be east toward Tonawanda Creek and the drainage ditches (fig. B-8). After water samples were withdrawn from these monitoring wells, recovery time often exceeded 48 hours, which indicates extremely slow ground-water movement.



Base from USGS field sketch, 1982

Figure B-8. Location of sampling holes and monitoring wells at Holiday Park, site 72, North Tonawanda.

Boring no.	Depth (ft)	Description
1	0 - 1.5	Dark topsoil, clay.
	1.5 - 5.0	Clay, greenish-gray.
	5.0 - 11.0	No returns; hit many kinds of debris, such as mattress springs, etc. Depth to water 5.15 ft below land surface
		WATER SAMPLE: 9.2 - 11.2 ft.
2	0 - 0.5	Topsoil with gravel fill.
	0.5 - 1.5	Clay, olive-drab, "modeling clay."
	1.5 - 3.0	Clay, sandy, yellowish, moist.
	3.0 - 3.5	Clay, brown/yellow, saturated, sandy.
	3.5 - 4.5	Clay, sandy, dry, yellow/buff.
	4.5 - 6.0	Clay, sandy, dry.
	6.0 - 7.5	Sand, very fine, rust stained.
	7.5 - 10.0	Clay, sandy, some gravel-size cherty material, may be fill.
	10.0 - 11.5	Clay, sandy.
	11.5 - 15.2	Clay, pinkish color.
		Water level 7.62 ft below land surface.
		WATER SAMPLE: 13.2 - 15.2 ft.
3	0 - 4.5	Topsoil, light to dark brown.
	4.5 - 6.0	Clay, sandy, greenish gray. Hit saturation at 6.0 ft
	6.0 - 15.0	Clay, very sandy, gray, saturated.
		Water level 7.62 ft below land surface.
		WATER SAMPLE: 12.4 - 14.4 ft.
4	0 - 2.0	Topsoil, dark brown to yellow tan.
	2 - 3.5	Topsoil, brown, wet at 3.5 ft.
	3.5 - 22.5	Clay, sandy, alternating brown and gray, wet. Hit hard layer at 22.5 ft. Bedrock? Camillus Shale?
		WATER SAMPLE: 20.5 - 22.5 ft.
6	0 - 1.5	Topsoil, black to brown.
	1.5 - 6.5	Clay, brown, wet.
	6.5 - 9.0	Same, water at 8.0 ft.
	9.0 - 11.5	Clay, pinkish, tight, "modeling clay."
	11.0 - 15.0	Same, extremely tight. Moved rig forward 3 ft and augered to clay.
		WATER SAMPLE: 13.0 - 15.0
7	0 - 1.0	Topsoil, black, organic.
	1.0 - 5.0	Clay, sandy, brown, saturated.
	5.0 - 6.5	Clay, tight, dry.
		SOIL SAMPLE: 3.5 ft.

Chemical information.--Recra Research completed an investigation of the site in 1979. The data are available from NYSDEC in Buffalo, N.Y. In 1982, the U.S. Geological Survey collected water samples from all seven monitoring wells, one soil sample, four samples of pond water from the golf course, and three sediment samples from the moist drainage ditches. All samples were analyzed for copper, iron, and organic compounds; results are shown in table B-8. Only iron exceeded the USEPA criterion for drinking water and the New York State standard for ground water. Only two organic priority pollutants were found; their concentrations were below 50 µg/L. The samples contained 15 organic nonpriority pollutants and 10 possibly naturally occurring compounds.

Table B-8.--Analyses of ground-water, surface-water, and sediment samples from Holiday Park, site 72, North Tonawanda, N.Y., June 19, 1982 to July 9, 1982.

[Locations shown in fig. B-8. Concentrations are in µg/L and µg/kg: dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit; blanks indicate it was not analyzed.]

	Sample number				
	Ground water				
	1	2	3	duplicate	4
pH	6.9	7.2	7.2		7.2
Specific conductance (µmho/cm)	2,140	1,160	760		470
Temperature (°C)	10.0	10.5	12.5		11.0
Inorganic constituents					
Copper	46	[2]11	8	(9)	25
Iron	90,000†	49,000	4,700†	(5,200†)	19,000†
Molecular sulfur[1]	--	--	--	(--)	--
Organic compounds					
Priority pollutants					
Dibutyl phthalate	--	--	--	(--)	31.8
Ethylbenzene[3]	17	--	--	(--)	--
Nonpriority pollutants					
4-(1,1-Dimethylethyl)-phenol[1]	LT	--	--	(--)	--
1,3-Isobenzofurandione[1]	LT	--	--	(--)	--
4-Chloro-transcyclohexanol[1]	--	--	LT	(--)	--
3-methycyclopentanone[1]	LT	--	--	(--)	--
2-Cyclohexen-1-one[1]	--	--	--	(--)	--
2-Cyclohexen-1-ol[1]	--	--	8.0	(--)	--
	--	--	LT	(--)	--
Compounds potentially of natural origin					
1,7,7-Trimethyl-bicyclo [2.2.1]heptan-2-one[1]	56	--	--	(--)	--
2-hexanone[1]	LT	--	--	(--)	--
1,3,3-Trimethyl-bicyclo [2.2.1]-heptan-2-one[1]	LT	--	--	(--)	--
1-Butoxy-2-propanol[1]	LT	--	--	(--)	--

Table B-8.--Analyses of ground-water, surface-water, and sediment samples from Holiday Park, site 72, North Tonawanda, N.Y., June 19, 1982 to July 9, 1982 (continued)

	Sample number		
	Ground water		
	5	(duplicate)	6
pH	8.0		7.0
Specific conductance (µmho/cm)	618		11.40
Temperature (°C)	9.0		11.0
Inorganic constituents			
Copper	7	(7)	[2]110
Iron	12,000†	(14,000†)	96,000†
Molecular sulfur	--	(--)	--
Organic compounds			
Priority pollutant			
Dibutyl phthalate	--	(2.0)	--
Nonpriority pollutants			
2-Cyclohexen-1-one[1]	LT	(--)	--
Ethanol,2[2-(2-		(--)	
methoxyethoxy)]-acetate	LT	(--)	--
2,2-Dimethyldecane[1]	LT	(--)	--
2-Butoxyethylbutyl phthalate[1]	--	(11.7)	--
4-Chloro-transcyclohexanol[1]	LT	(--)	13
1-(2-butoxyethoxy)ethanol[1]	--	(--)	49

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

[2] Analysis done by direct aspiration because of high iron concentration.

[3] Volatile found in GC/MS extractions. Concentration probably higher than that detected.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

***Analyzed at detection limit above that required by this study. No compounds detected.

Table B-8.--Analyses of ground-water, surface-water, and sediment samples from Holiday Park, site 72, North Tonawanda, N.Y., June 19, 1982 to July 9, 1982 (continued)

[Locations shown in fig. B-8. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit; blanks indicate it was not analyzed.]

	Sample number		
	Sediment		Ground water
	7	duplicate	8
pH			7.4
Specific conductance (μmho/cm)			1,050
Temperature (°C)			11.0
Inorganic constituents			
Copper	6,000	(6,000)	60
Iron	2,200,000	(2,300,000)	37,000†
Molecular sulfur	--	(--)	LT
Organic compounds			
Nonpriority pollutants			
3,3-dimethyl-2-butanone[1]	1,000	(--)	--
2-butanone[1]	21,000	(--)	--
2-methylheptane[1]	2,300	(--)	--
acetic acid,1-methyl ester[1]	3,650	(--)	--
2,6-dimethyl heptane[1]	2,850	(--)	--
2-methyl-2-proply-1,3-dioxolane	710	(--)	--
2,2'-oxybispropane[1]	4,200	(--)	--
2,6-dimethyloctane[1]	560	(--)	--
Compounds potentially of natural origin			
undecane[1]	2,400	(--)	--
tridecane[1]	2,200	(--)	--
2,7-dimethylundecane[1]	710	(--)	--
2,3,5-Trimethyldecane[1]	2,208	(--)	--
Possible artifact			
4-methyl-3-penten-2-one[1]	4,100	(LT)	--

Table B-8.--Analyses of ground-water, surface-water, and sediment samples from Holiday Park, site 72, North Tonawanda, N.Y., June 19, 1982 to July 9, 1982 (continued)

[Locations shown in fig. B-8. Concentrations are in µg/L and µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit; blanks indicate it was not analyzed.]

	Sample number				
	Sediment	Surface water		Sediment	
	9	10	duplicate	11	12
pH		9.0			
Specific conductance (µmho/cm)		63			
Temperature (°C)		24.0			
Inorganic constituents					
Aluminum		--	(--)		
Antimony		--	(--)		
Arsenic		--	(--)		
Barium		--	(--)		
Beryllium		--	(--)		
Cadmium		--	(--)		
Chromium		--	(--)		
Cobalt		--	(--)		
Copper	8,000	--	(--)	5,000	14,000
Iron	3,600,000	198	(205)	1,800,000	370,000
Lead		33	(36)		
Manganese		21	(24)		
Mercury		--	(--)		
Nickel		--	(--)		
Selenium		--	(--)		
Silver		--	(--)		
Tellurium		--	(--)		
Vanadium		--	(--)		
Zinc		17	(16)		
Organic compounds	***			***	***
Priority pollutant					
Di-n-butyl phthalate	--	--	(20)	--	--
Nonpriority pollutants					
1,3-Dimethylbenzene	--	--	(29)	--	--
Cyclohexanone	--	--	(29)	--	--

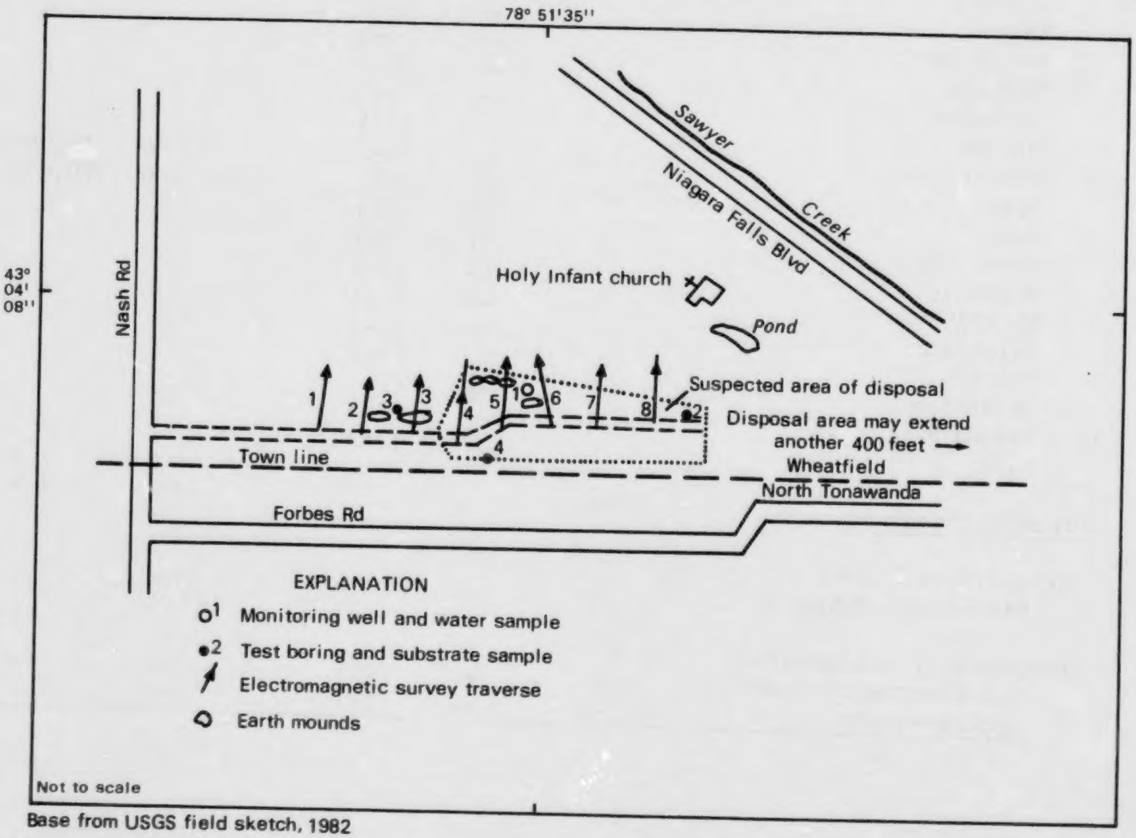
93. NASH ROAD (USGS field reconnaissance)

NYSDEC 932054

General information and chemical-migration potential.--The Nash Road site, in the town of Wheatfield, was used by seven firms for disposal of an unknown quantity of caustics, plating-tank sludge, and municipal waste during 1964-68. Material excavated during construction of a highway adjacent to the southern border of the Love Canal was buried in a trench 100 ft by 30 ft across and 27 ft deep in the northeast corner of the site. Clean fill 15 ft deep was reportedly placed over the material.

The potential for contaminants to travel downward through the underlying clay seems limited, and the potential for lateral migration cannot be evaluated from the available data. The chemical data indicate several organic compounds in the ground water, but the rate at which these compounds move is unknown. Additional data and monitoring would be needed to confirm offsite migration. Thus, the potential for contaminant migration is indeterminable.

Geologic information.--The site consists of a Holocene lacustrine clay unit overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled four test borings on the site in 1982; the locations are shown in figure B-9. The geologic logs are as follows:



Base from USGS field sketch, 1982

Figure B-9. Location of monitoring wells and electromagnetic-conductivity survey lines at Nash Road, site 93, Wheatfield.

Boring no.	Depth (ft)	Description
1	0 - 5.0	Fill.
	5.0 - 6.5	Clay, pink.
		WATER SAMPLE: 6.0 ft.
2	0 - 8.0	Clay, tan to light green, sandy, dry.
	8.0 - 10.0	Clay, green.
	10.0 - 11.5	Clay, pink.
		SOIL SAMPLE: 8 - 10 ft.
3	0 - 1.5	Tan and black fill.
	1.5 - 3.5	Clay, greenish, sandy, dry.
	3.5 - 7.0	Clay, greenish, sandy, wet.
		SOIL SAMPLE: 7 ft.
4	0 - 1.0	Topsoil.
	1.0 - 3.5	Clay, sandy, dry.
	3.5 - 6.5	Clay, greenish, wet.
		SOIL SAMPLE: 6.5 ft.

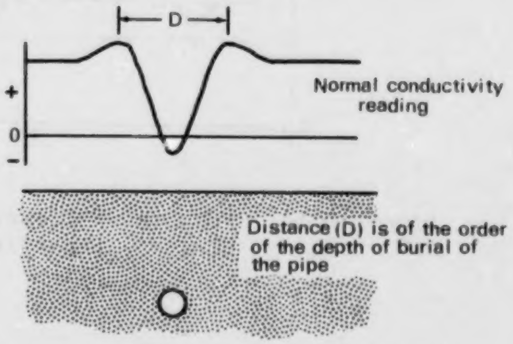
Hydrologic information.--Ground water was encountered approximately 6 ft below land surface. The water table is estimated to be between 570 and 575 ft above NGVD. The direction of ground-water flow is probably northeastward toward Sawyer Creek, a tributary to Cayuga Creek, but additional wells would be needed to confirm this.

Chemical information.--In 1982, the Geological Survey collected one water sample and three soil samples for arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and organic-compound analyses. Results are given in table B-9. In sample 2, copper concentrations exceeded those in soils from undisturbed sites, and in sample 1, iron and lead exceeded USEPA criteria for drinking water and the New York State standard for ground water. The samples contained five organic priority pollutants, but except for fluoranthene (538 μg/kg), concentrations were not above the quantifiable detection limit. In addition, 39 organic nonpriority pollutants and four possibly naturally occurring compounds were found.

The site was also investigated by Recra Research in 1979 and by NYSDEC in 1983. The data are available from NYSDEC in Buffalo, N.Y.

Electromagnetic survey.--The Geological Survey ran an electromagnetic survey with eight traverses in November 1982; locations are shown in figure B-9. The effect of buried pipe is evident in the stripchart in fig. B-10.

Figure B-10. Effect of buried pipe on electromagnetic-conductivity reading.


D
+
0
-
Normal conductivity reading
Distance (D) is of the order of the depth of burial of the pipe

The southern parts of lines 1 through 8 (fig. B-11) show the effects of interference by a series of high-power electrical transmission lines. These powerlines and a housing development south of them made it impossible to begin the southern end of each line in a waste-free area.

Lines 1, 2, and 3 show an irregular pattern of conductivity values within the disturbed area. Beyond the trees that form the northern border of the site, the conductivity values are within the background range.

Lines 4, 5, and 6, though longer than the first three lines, show a similar pattern. Areas of zero conductivity probably correspond to a zone of buried metallic debris. (When readings are taken over a buried pipe or other metal conductor, the conductivity value first rises, then drops to zero.)

Line 7 both begins and ends in a obvious zone of dumping. Data collection beyond 340 ft was impeded by a small pond. Line 8 shows the clearest example of powerline interference; the conductivity range throughout this line becomes artifically elevated within 40 ft of the powerlines.

No definite conclusions could be made from the survey. Variability of fill and interferences make data interpretation questionable.

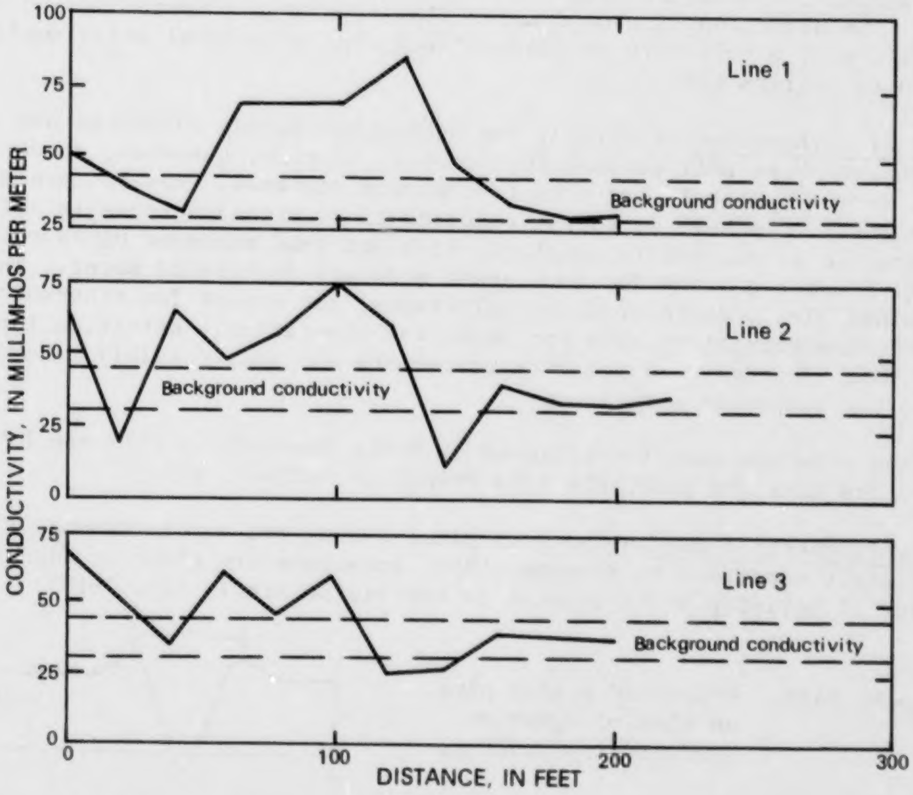


Figure B-11. Results of electromagnetic-conductivity survey at Nash Road, site 93, Wheatfield. (Locations of lines are shown in fig. B-10.)

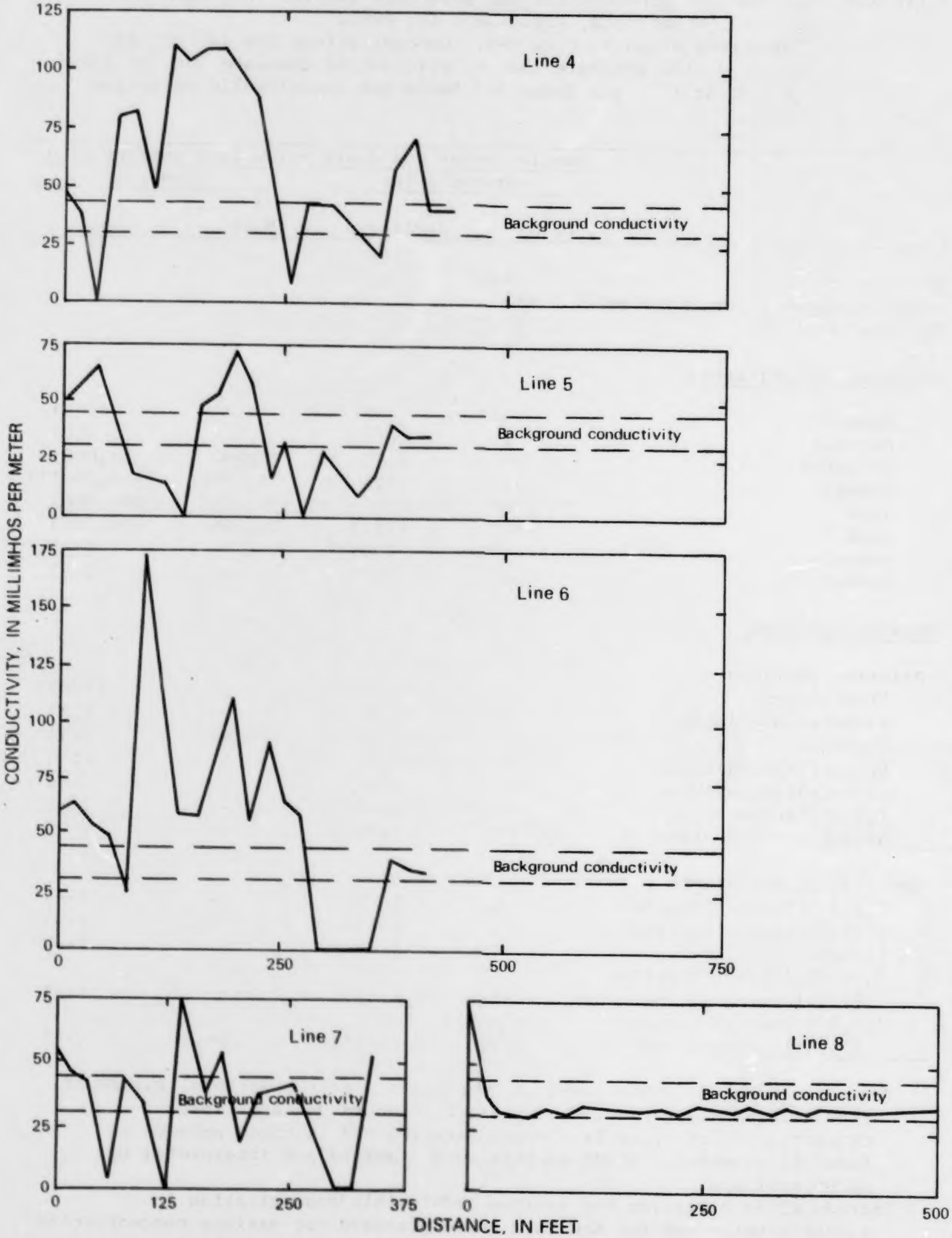


Figure B-11 (continued). Results of electromagnetic-conductivity survey at Nash Road, site 93, Wheatfield.

Table B-9.--Analyses of ground-water and substrate samples from Nash Road, site 93, Wheatfield, N.Y., June 24, 1982.
[Locations shown in fig. B-9. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	Ground water		Substrate	
	1 (6.0)	duplicate	2 (9.5)	split
pH	6.4			
Specific conductance (μmho/cm)	2,650			
Temperature (°C)	17.0			
Inorganic constituents				
Arsenic	5†	(5†)	--	(--)
Cadmium	1	(1)	1,000	(1,000)
Chromium	--	(--)	2,000	(4,000)
Copper	17	(21)	77,000††	(100,000††)
Iron	90,000†	(90,000†)	2,500,000	(5,000,000)
Lead	67†	(74†)	20,000	(20,000)
Mercury	0.3	(0.5)	--	(--)
Nickel	34	(34)	--	(--)
Organic compounds				
Priority pollutants				
Fluoranthene	--	(--)	--	(538)
Benzo(a)anthracene	--	(--)	--	(LT)
Chrysene	--	(--)	--	(LT)
Benzo(b)fluoranthene	--	(--)	--	(LT)
Benzo(k)fluoranthene	--	(--)	--	(LT)
1,4-dichlorobenzene	7.3	(--)	--	(--)
Di-n-butyl phthalate	LT	(5.7**)	--	(--)
Nonpriority pollutants				
1,2,3-Trimethylbenzene[1]	6.2	(--)	--	(--)
1,2,4-trimethylbenzene[1]	18	(--)	--	(--)
(1-methylethyl)benzene[1]	9.3	(--)	--	(--)
1,3,3-Trimethyl-bicyclo-[2.2.1]heptan-2-one[1]	62	(--)	--	(--)
1,7,7-Trimethyl-bicyclo-[2.2.1]heptan-2-one[1]	390	(17**)	--	(--)

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water and the New York State standard for maximum concentration in ground water.

†† Exceeds concentrations in samples taken from undisturbed soils in the Tonawanda area. Undisturbed soils not analyzed for iron.

** Surrogate recoveries were outside the acceptance limits.

Table B-9.--Analyses of ground-water and substrate samples from Nash Road, site 93, Wheatfield, N.Y., June 24, 1982 (continued)
[Locations shown in fig. B-9. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)	
	Substrate	
	3	4 (6.5)
pH		
Specific conductance (μmho/cm)		
Temperature (°C)		
Inorganic constituents		
Arsenic	--	--
Cadmium	1,000	1,000
Chromium	2,000	2,000
Copper	71,000	71,000
Iron	2,100,000	2,400,000
Lead	13,000	20,000
Mercury	--	--
Nickel	--	--
Organic compounds		
Priority pollutant		
D-n-butyl/phthalate	--	--
Nonpriority pollutants		
1,2,3-Trimethylbenzene[1]	LT	--
1,2,4-trimethylbenzene[1]	LT	--
1,4-dichlorobenzene[1]	LT	--
(1-methylethyl)benzene[1]	LT	--
1,3,3-Trimethyl-bicyclo-[2.2.1]heptan-2-one[1]	LT	--
1,7,7-Trimethyl-bicyclo-[2.2.1]heptan-2-one[1]	LT	--

Table B-9.--Analyses of ground-water and substrate samples from Nash Road, site 93, Wheatfield, N.Y., June 24, 1982 (continued) [Locations shown in fig. B-9. Concentrations are in µg/L and µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number					
	Ground water		Substrate			
	1	(duplicate)	2	(split)	3	4
Organic compounds (continued)						
Nonpriority pollutants (continued)						
1,7,7-Trimethyl-bicyclo [2.2.1]heptane-2,5-dione[1]	LT	(20**)	--	(--)	--	--
3-(1,1-dimethylethyl) phenol[1]	20	(LT**)	--	(--)	--	--
2-methylbenzo chloride[1]	LT	(--)	--	(--)	--	--
Diethyl phthalate[1]	6.2	(8.0**)		(--)		
Phosphoric acid tributylester[1]	10	(110**)	--	(--)	--	--
2(3H)-benzothiazolone	LT	(60**)	--	(--)	--	--
1,2,3,4,4a,9,10,10a-octahydro-1,4a-dimethyl-7-(1-methyethyl)-[1R-(1 alpha, 4a beta, 10a alpha)]-1-phenanthrenecarboxaldehyde[1]	LT	(LT**)	--	(--)	--	--
Cyclohexl phthalate[1]	LT	(--)	--	(--)	--	--
3,5-Dimethylphenol[1]	--	(11**)	--	(--)	--	--
2-ethyl-4-phenol-.delta. 2-1,3,4-oxadiazolin-5-one[1]	--	(100**)	--	(--)	--	--
n-butylbenzenesulfonamide[1]	--	(9.9**)	--	(--)	--	--
3-(2-phenylethyl)phenol[1]	--	(LT**)	--	(--)	--	--
2H-1-benzopyran[1]	--	(LT**)	--	(--)	--	--
2-methylpentadecane[1]	--	(LT**)	--	(--)	--	--
4,8,12-Trimethyl-3, 7,11-tridecatriene-nitrile[1]	--	(LT**)	--	(--)	--	--
o-methyloxime-3,5-dimethyl-2-cyclohexen-1-one[1]	--	(--)	804	(--)	--	--
Iococyclohexane[1]	--	(--)	10,052	(--)	--	--
N-[2-methyl-1-(1-methylethyl) bitulidiene]methanamine[1]	--	(--)	36,569	(--)	--	--

Table B-9.--Analyses of ground-water and substrate samples from Nash Road, site 93, Wheatfield, N.Y., June 24, 1982 (continued)
[Locations shown in fig. B-9. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

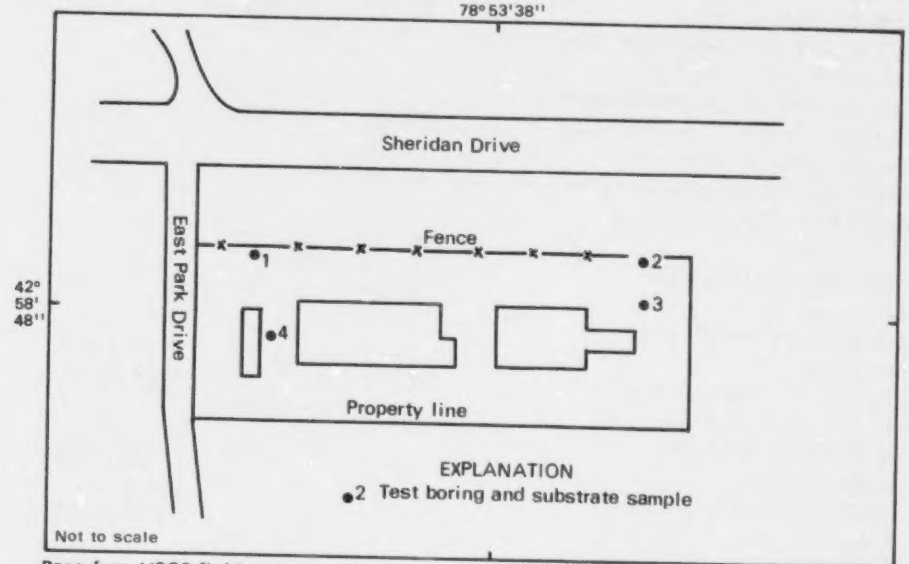
	Sample number					
	Ground water		Substrate			
	1	(duplicate)	2	(split)	3	4
Organic compounds (continued)						
Nonpriority pollutants (continued)						
N-(2-hydroethyl)-dodecanamide[1]	--	(--)	16,342	(--)	--	--
1-(2-butenyl)-2,3-dimethylbenzene[1]	--	(--)	1,301	(--)	--	--
2,3,5,6,7,8,9,10-octahydri-5-hydroxy-2,2,7,7,9-pentamethyl-5,9-menthanobenzocycloocten-4(1H)-one	--	(--)	6,294	(--)	--	--
10-methylisocosane[1]	--	(--)	LT	(--)		
Hexamethylcyclotrisiloxane[1]	--	(--)	--	(--)	--	1,300
Octamethylcyclotetrasiloxane[1]	--	(--)	--	(--)	--	5,440
Decamethylcyclopentasiloxane[1]	--	(--)	--	(--)	--	LT
Dodecamethylcyclohexasiloxane[1]	--	(--)	--	(--)	--	90.7
5-Methyl-3-hexen-2-one[1]	--	(--)	--	(3,500)	--	--
Dichloromethylbenzene[1]	--	(--)	--	(LT)	--	--
2-(1,1-Dimethyl)-4-methylfuran[1]	--	(--)	--	(183,000)	--	--
2,4-Dimethyl-2-pentene			--	(182,000)	--	--
3-Octanol[1]			--	(45,000)	--	--
2,6-Bis(1,1-dimethylethyl) naphthalene[1]	--	(--)	--	(1,650)	--	--
1,1,4,5,5,8-Hexamethyl-S-hydrindacene[1]	--	(--)	--	(5,750)	--	--
2,6-Dimethyl-2,5-heptadien-4-one[1]	--	(--)	--	(--)	509	--
2-Methyl-2-octen-4-one[1]	--	(--)	--	(--)	13,300	--
1,2,4-Trimethyl-5-(1-methylethenyl)benzene[1]	--	(--)	--	(--)	159	--
Compounds potentially of natural origin						
Heptadecane[1]	--	(LT**)	--	(--)	--	--
Octacosane[1]	--	(LT**)	--	(--)	--	--
Nonadecane[1]	--	(LT**)	--	(--)	--	--
3,8-Dimethylundecane[1]	--	(LT**)	--	(--)	--	--

103. R. P. ADAMS COMPANY (USGS field reconnaissance) NYSDEC 915001

General information and chemical-migration potential.--The R. P. Adams Company site, in the city of Tonawanda, was used as a parking lot on which waste oil was applied at a rate of 165 gal/yr for dust control. Chemical results indicate disposal of some hazardous materials.

Downward movement of contaminants through the extensive underlying clay is unlikely. Horizontal migration may occur during periods of excessive precipitation; but a more detailed investigation would be needed to confirm this. The potential for contaminant migration is indeterminable.

Geologic information.--The site consists of glacial lacustrine clay overlying bedrock of Camillus Shale. Depth to bedrock is approximately 60 ft. The U.S. Geological Survey drilled four test borings on the site in 1982; locations are shown in figure B-12. The geologic logs are on p. 209.



Base from USGS field sketch, 1982

Figure B-12. Location of sampling holes at R. P. Adams Company, site 103, Tonawanda.

Hydrologic information.--No ground water was encountered in the test drilling.

Chemical information.--The U.S. Geological Survey collected a soil sample at each borehole for iron, lead, and organic-compound analyses; results are given in table B-10. Substrate sample 4 showed eight organic priority pollutants in concentrations at or above 3,500 ug/kg. Only fluoranthene was found in any other sample (sample 3 at 640 ug/kg). The pollutants in sample 4 may be associated with the rubble encountered during the test drilling.

Boring no.	Depth (ft)	Description
1	0 - 5.0	Clay, red, dry except for top 1 inch. SAMPLE: 1 ft.
2	0 - 1.5	Clay, red, dry. SAMPLE: 1 ft.
3	0 - 1.5	Clay, red, dry. SAMPLE: 1 ft.
4	0 - 1.5	Topsoil and rubble
	1.5 - 2.0	Same.
	2.0 - 6.5	Clay, red, dry, tight. SAMPLE: 1 ft.

Table B-10.--Analyses of substrate samples from R. P. Adams Co., site 103, Tonawanda, N.Y., August 11, 1982.
[Locations shown in fig. B-12. Concentrations are in µg/kg; dashes indicate compound was not found.]

	Sample number and depth below land surface (ft)			
	1 (1.0)	2 (1.0)	3 (1.0)	4 (1.0)
Inorganic constituents				
Iron	3,400,000	2,800,000	2,500,000	2,400,000
Lead	30,000	10,000	30,000	20,000
Organic compounds				
Priority pollutants				
Fluoranthene	--	--	640	4,900
Phenanthrene	--	--	--	5,700
Pyrene	--	--	--	4,400
Benzo(a)anthracene	--	--	--	3,500
Chrysene	--	--	--	4,100
Benzo(b)fluoranthene	--	--	--	5,750
Benzo(k)fluoranthene	--	--	--	4,700
Benzo(a) pyrene	--	--	--	4,850
Non-priority pollutant				
1,1-Ethanediol, diacetate[1]	--	--	6,700	--

---

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

105. ALLIED CHEMICAL, TONAWANDA (USGS field reconnaissance) NYSDEC 915003-b

General information and chemical-migration potential.--The Allied Chemical site, an area 40 ft in diameter in the western part of the town of Tonawanda, was used during 1950-60 to dispose of an unknown quantity of scrap clorinated and nonchlorinated polyethylene and spent catalyst.

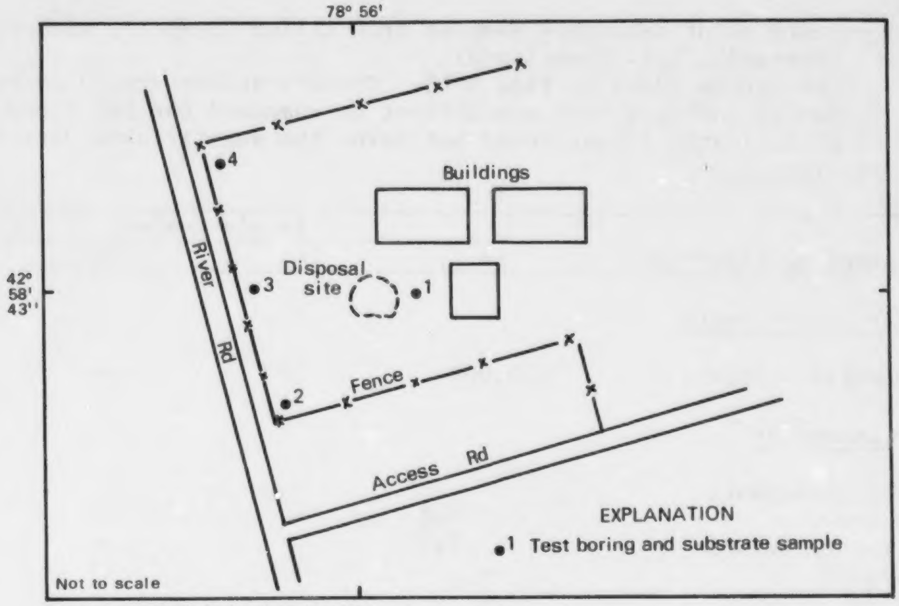
Chemical data indicate migration of contaminants from the site, specifically chromium, lead, and nickel. The potential for contaminant migration could be major, but additional information would be needed to confirm this.

Geologic information.--The site consists of a lacustrine clay deposit overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled four test borings on the site in 1982; their locations are shown in figure B-13. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 2.5	Gravel fill.
	2.5 - 9.5	Clay, debris, sand, dark green.
	9.5 - 11.5	Clay, pink, tight and dry.
		SOIL SAMPLE: 6.5 ft.
2	0 - 3.5	Topsoil, black, wet.
	3.5 - 11.5	Clay, pink, very dry. Moved a few feet to redrill to 3.5 ft.
		SOIL SAMPLE: 3 ft.
3	0 - 3.0	Very little if any topsoil. Went almost immediately into red, dry clay.
	3.0 - 5.0	Clay, gray-green, dry.
	5.0 - 6.5	Clay, tan.
	6.5 - 10.0	Clay, red, dry.
		SOIL SAMPLE: 5 ft.
4	0 - 4.3	Clay, red.
	4.3 - 5.0	Clay, dark green.
	5.0 - 6.0	Clay, yellowish, sandy.
	6.0 - 6.5	Clay, red.
		SOIL SAMPLE: 5 ft.

Hydrologic information.--No substantial ground water was encountered in the test boring. The upper part of the clay unit was moist, indicating the possibility of a perched water table during periods of high precipitation. The direction of ground-water flow is probably westward toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected four soil samples for arsenic, cadmium, chromium, iron, lead, mercury, nickel, and organic-compound analyses; results are given in table B-11. Chromium and lead concentrations in samples 1 and 2 were above those in samples from undisturbed soils in the Tonawanda area. The samples contained 21 organic priority pollutants and 11 nonpriority pollutants.



Base from USGS field sketch, 1982

Figure B-13. Location of sampling holes at Allied Chemical, Tonawanda, site 105, Tonawanda.

Table B-11.--Analyses of substrate samples from Allied Chemical, site 105, Tonawanda, N.Y.
[Locations shown in fig. B-13. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1	2	3	4
First sampling (7-20-82)	6.5	3.0	5.0	5.0
Inorganic constituents				
Arsenic	--	--	--	--
Cadmium	1,000	3,000	--	1,000
Chromium	90,000††	80,000††	3,000	4,000
Iron	5,200,000	2,000,000	2,000,000	25,000,000
Lead	170,000††	200,000††	--	30,000
Mercury	20	--	--	--
Nickel	60,000	120,000	20,000	20,000

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from undisturbed soils in the Tonawanda area. Undisturbed soils not analyzed for iron.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

Table B-11.--Analyses of substrate samples from Allied Chemical, site 105, Tonawanda, N.Y. (continued)
[Locations shown in fig. B-13. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

Second sampling (5-19-83)	Sample number			
	1A	2A	3A	4A
Inorganic constituents				
Molecular sulfur[1]	450,000	360	--	580
Organic Compounds				
Priority pollutants				
Benzene	6.2	--	--	--
Tetrachloroethene	9.8	--	--	--
Dieldrin	--	--	LT	LT
Aldrin	--	--	--	LT
Heptachlor	--	--	--	LT
Acenaphthene	--	*	--	--
Fluoranthene	*	*	*	--
Naphthalene	*	*	*	--
Bis(2-ethylhexl) phthalate	--	--	*	*
Di-n-butyl phthalate	--	*	--	--
Benzo(a)anthracene	*	*	*	--
Benzo(a)pyrene	*	*	*	--
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	*	*	--
Chrysene	*	*	*	--
Acenaphthylene	--	*	--	--
Benzo(ghi)perylene	--	*	*	--
Fluorene	--	*	--	--
Phenanthrene	--	*	--	--
Dibenzo(a,h)anthracene	--	*	--	--
Indeno(1,2,3-cd)pyrene	--	*	*	--
Pyrene	*	*	*	--
Nonpriority pollutants				
Carbon disulfide	26.6	--	--	--
O-xylene	3.6	--	--	--
Dibenzofuran	--	*	--	--
2-Methylnaphthalene	--	*	--	--
2-Chloro-transcyclohexanol[1]	--	*	--	--
9-Methylphenanthrene[1]	--	*	--	--
3-Methylphenanthrene[1]	--	*	--	--
4H-Cyclopenta(def)-phenanthrene[1]	--	*	--	--
2-Methylphenanthrene[1]	--	*	--	--
1-Methylpyrene[1]	--	*	--	--
Perylene[1]	--	*	--	--

106. ALLIED CHEMICAL, TONAWANDA (Literature review) NYSDEC 915003-c

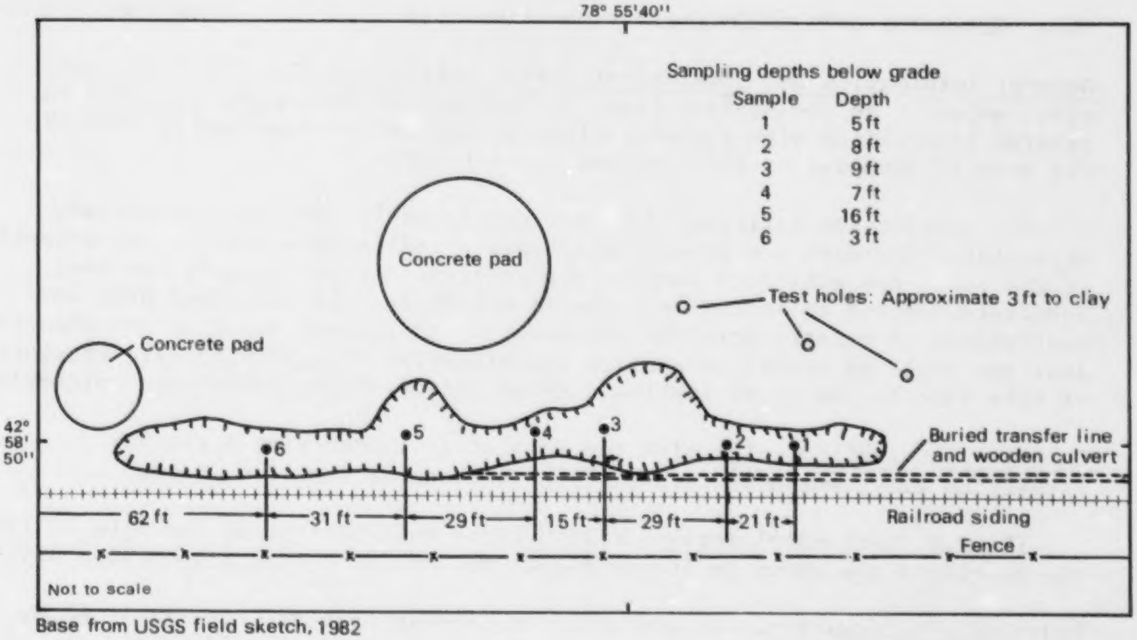
General information and chemical-migration potential.--The Allied Chemical site, in the western part of the town of Tonawanda, consisted of pools of coal tar from spillage and leakage during product-transfer operations. The amount is unknown. In 1981, the material was removed and new fill added (fig. B-14).

The site has an indeterminable potential for contaminant migration. The chemical data indicate some contamination within the site but given no evidence of contaminant migration.

Geologic information.--The site consists of a lacustrine clay deposit overlying bedrock of Camillus Shale.

Hydrologic information.--No hydrologic information is available, but the conditions are probably similar to those of adjacent site 105. Ground-water flow is probably toward the river.

Chemical information.--The company collected six soil samples from the fill area and analyzed them for several organic compounds associated with the coal-tar fill; results are shown in table B-12. Samples contained eight priority pollutants, all below 100 µg/kg.



Base from USGS field sketch, 1982

Figure B-14. Location of sampling holes at Allied Chemical, Tonawanda, site 106, Tonawanda.

Table B-12.--Analyses of soil samples from Allied Chemical, site 106, Tonawanda, N.Y.[1]
[Locations are shown in fig. B-14. Concentrations are in μg/kg. Dashes indicate that compound was not found.[2]]

Constituent	Sample number					
	1	2	3	4	5	6
Acenaphtene	--	22	61	--	--	--
Acenaphthylene	--	--	13	--	--	--
Fluorene	--	18	84	--	--	--
Naphthalene	--	--	65	--	--	--
Phenanthrene/ anthracene	--	14	98	--	15	--
Phenol	--	14	--	--	--	--
2,4 Dimethylphenol	--	76	--	--	--	--

[1] Data from Allied Chemical Fibers and Plastics Company, Tonawanda, N.Y.
[2] Limit of detection = 10 ug/kg

108. TONAWANDA COKE (USGS field reconnaissance) NYSDEC 915055-a

General information and chemical-migration potential.--The Tonawanda Coke site, adjacent to the Niagara River in the town of Tonawanda, was used for general landfilling with fly ash, cinders, and tar sludges during 1930-79. The rate of disposal on the site was 4,680 tons/yr.

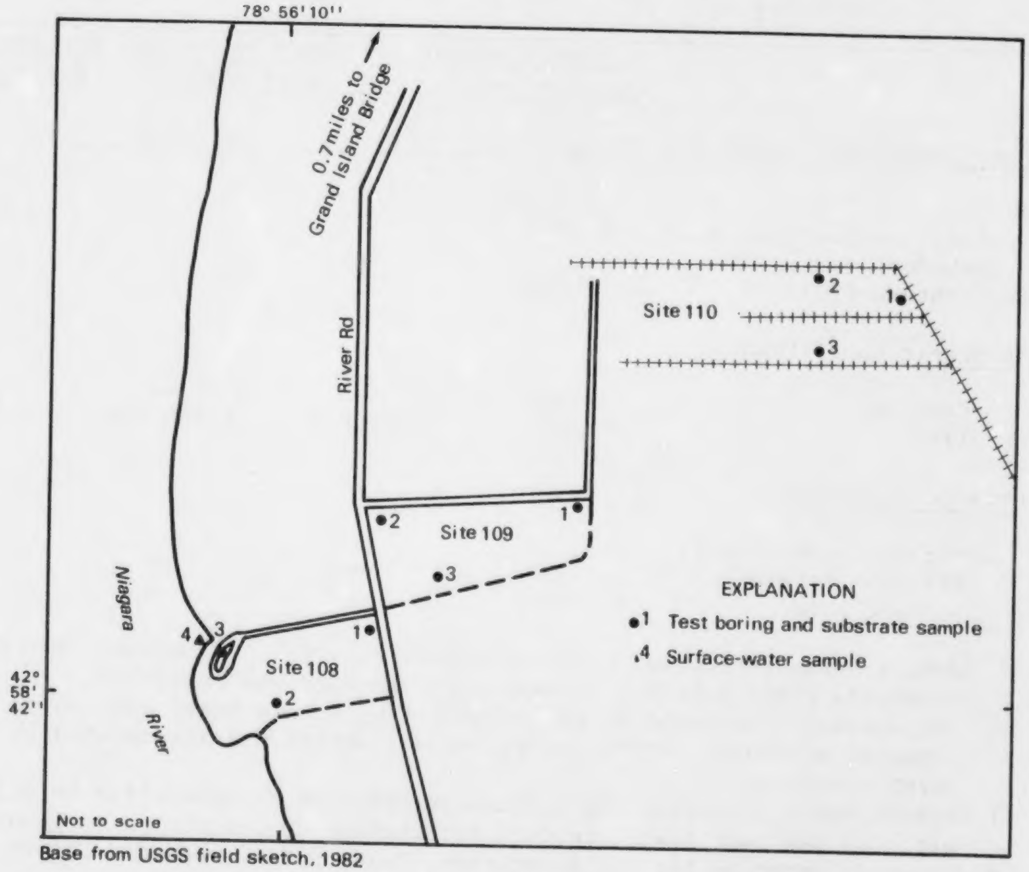
The information collected does not conclusively indicate contaminant migration. Although one ground-water sample indicates a cyanide concentration of 280 ug/L, two substrate samples downgradient did not contain cyanide. Substrate samples collected near the riverbank in 1983 contained high concentrations of organic priority pollutants. Additional sampling and chemical analyses would be needed to confirm the migration of contaminants. Proximity of this site to the river implies a major potential for contaminant migration.

Geologic information.--The site consists of fill overlying a glacial lacustrine clay, which in turn overlies bedrock of Camillus Shale.

The U.S. Geological Survey drilled three test borings on the site in 1982; the locations are shown in figure B-15. The geologic logs are on page 215.

Hydrologic information.--Ground water was encountered at 11 to 12 ft below land surface. The probable direction of ground-water flow is toward the Niagara River.

Boring no.	Depth (ft)	Description
1	0 - 4.0	Topsoil, fill.
	4 - 6.5	Clay, some sand, dry, dark green.
	6.5 - 9.0	Clay, some sand, olive green.
	9.5 - 11.5	Clay, dark green, almost blue, wet right at bottom, sandy.
	11.5 - 16.5	Clay, olive green, tight. SAMPLE: 15.5 - 16.5 ft
2	0 - 2.0	Topsoil.
	2 - 3.5	Black organic soil.
	3.5 - 6.0	Clay, sandy, black dry.
	6.0 - 11.5	Fly ash, cinders, black, wet. SAMPLE: 6.0 ft.
3	0 - 2.0	Topsoil.
	2 - 8.0	Clay, red, tight, sandy, dry.
	8 - 11.5	Black, organic, mixed with red clay. SAMPLE: 8.0 ft.



Base from USGS field sketch, 1982

Figure B-15. Location of sampling holes and surface sample at Tonawanda Coke, sites 108, 109, and 110, Tonawanda.

Chemical information.--The Geological Survey collected one ground-water sample and two soil samples from the boreholes on the site and a surface-water sample from a drainage ditch near the Niagara River. Each sample was analyzed for cyanide, iron, and organic compounds; results are given in table B-13.

Iron exceeded the USEPA criterion for drinking water and New York State ground-water standard in both water samples, and cyanide exceeded the criterion and standard in sample 1. Substrate samples contained 17 organic priority pollutants; vinyl chloride concentration was 2,100 ug/kg. Also 12 nonpriority pollutants and some unknown hydrocarbons were found.

Table B-13.--Analyses of ground-water, surface-water, and substrate samples from Tonawanda Coke, site 108, Tonawanda, N.Y.
[Locations shown in fig. B-15. Concentrations are in µg/L and µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	Ground water	Substrates		Surface water
	1	2	3	4
First sampling (7-13-82)	(16.5)	(6.0)	(8.0)	
pH	6.8			7.2
Specific conductance (µmho/cm)	1,480			1,020
Temperature (°C)	12.0			26.2
Inorganic constituents				
Cyanide	280†	--	--	30
Iron	170,000†	9,500,000	5,900,000	2,400†
Organic compounds				
Nonpriority pollutants				
Diethyl phthalate	LT	--	--	--
Benzoic acid	LT	--	--	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

** Surrogate recoveries were above or below the acceptance limits.

Table B-13.--Analyses of ground-water, surface-water, and substrate samples from Tonawanda Coke, site 108, Tonawanda, N.Y. (continued) [Locations shown in fig. B-15. Concentrations are in µg/L and µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number	
	Substrates	
Second sampling (5-24-83)	2A	3A
Inorganic constituents		
Molecular sulfur[1]	11,000	--
Organic Compounds		
Priority pollutants		
Benzene	32.2**	134**
1,2-Trans-dichloroethene	--	468**
Ethylbenzene	28.5**	150**
Methylene chloride	45.0**	--
Tetrachloroethene	--	33.0**
Toluene	16.1**	363**
Vinyl chloride	--	2,180**
Acenaphthene	*	--
Fluoranthene	*	--
Naphthalene	*	*
Bis(2-ethylhexl) phthalate	*	--
Benzo(a)anthracene	*	--
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	--
Acenaphthylene	*	--
Benzo(ghi)perylene	*	--
Fluorene	*	--
Indeno(1,2,3-cd)pyrene	*	--
Pyrene	*	--
Nonpriority pollutants		
Acetone	--	352**
Carbon disulfide	44.2**	247**
O-xylene	126**	530**
Dibenzofuran	*	--
2-Methylnaphthalene	*	--
2,3-Dihydro-1H-indene[1]	*	--
1H-Indene[1]	*	--
Cyclohexane[1]	--	*
Methylcyclopentane[1]	--	*
1,1,3-Trimethyl-cyclohexane[1]	--	*
2,2,3,4-Tetramethylpentane[1]	--	*
1-Ethyl-3-methyl-trans-cyclopentane[1]	--	*
2,6,6-Trimethyl-bicyclo-(3.1.1)hepten-2-ene[1]	--	*
Unknown hydrocarbons[1]	--	*

109. TONAWANDA COKE (USGS field reconnaissance) NYSDEC 915055

General information and chemical-migration potential.--The Tonawanda Coke site, in the town of Tonawanda, was used as a general landfill for bricks, rubble, and demolition material during 1930-78. The quantity of material disposed of is unknown.

The potential for vertical migration through the extensive clay unit underlying the site is probably limited. Data are insufficient to evaluate horizonal migration from the site; therefore the contaminant-migration potential is indeterminable.

Geologic information.--The site consists of fill overlying a glacial lacustrine clay that is in turn underlain by bedrock of Camillus Shale.

The U.S. Geological Survey drilled three test borings on the site in 1982; the locations are shown in figure B-15. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 2.5	Black organic topsoil and gravel.
	2.5 - 11.5	Clay, red, very dry.
		NO SAMPLE (no permeable zone below surface).
2	0 - 3	Topsoil.
	3 - 10	Clay, greenish, sandy, some water right at bottom.
	10 - 16.5	Clay, red, tight.
		WATER SAMPLE: 11 ft.
		SOIL SAMPLE: 5.5 ft.
3	0 - 1.5	Black fill.
	1.5 - 5.0	Clay, sandy, brown-red.
	5.0 - 16.5	Clay, reddish, tight, dry.
		NO SAMPLE (no permeable zone below surface).

Hydrologic information.--Ground water was encountered at approximately 10 ft below land surface. The probable direction of ground-water flow is westward toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected a ground-water sample, a soil sample, and a surface-water sample in 1982, and three substrate samples in 1983. The ground-water and soil samples were analyzed for organic compounds; the surface-water sample was analyzed for several inorganic and organic compounds. Results are given in table B-14. In the surface-water sample, chromium, iron, and lead exceeded USEPA criteria for drinking water, and one organic priority pollutant was found. In the substrate samples, 21 organic priority pollutants, 16 organic nonpriority pollutants, one possibly naturally occurring organic compound, and some unknown hydrocarbons were found. The pH of the surface-water sample was very low.

Table B-14.--Analyses of surface-water, ground-water and substrate samples from Tonawanda Coke, site 109, Tonawanda, N.Y.

[Locations shown in fig. B-15. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)	
	Surface water	Ground water
First sampling (7-14-82)	1 (0.2)	2 (11.0)
pH	3.2	6.8
Specific conductance (umho/cm)	3,000	1,600
Temperature (°C)	21.0	13.0
Inorganic constituents		
Aluminum	1,300	
Antimony	--	
Arsenic	--	
Barium	284	
Beryllium	--	
Cadmium	3	
Chromium	1,100†	
Cobalt	65	
Copper	724	
Iron	280,000†	
Lead	120†	
Manganese	5,040	
Mercury	0.3	
Nickel	244	
Selenium	--	
Silver	--	
Tellurium	--	
Vanadium	--	
Zinc	192	
Organic compounds		
Priority pollutant		
Di-n-butyl phthalate	LT	--
Nonpriority pollutant		
1,2-dimethylbenzene[1]	26	--
Compound potentially of natural origin		
Undecane[1]	--	5.0

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water.

Table B-14.--Analyses of surface-water, ground-water and substrate samples from Tonawanda Coke, site 109, Tonawanda, N.Y. (continued)
[Locations shown in fig. B-15. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
	Substrates		
Second sampling (5-24-83)	1A (2.0)	2A (4.0)	3A (3.0)
Inorganic constituent			
Molecular sulfur[1]	--	1,900	--
Organic compounds			
Priority pollutants			
Benzene	5.7**	8.3	--
1,1,1-Trichloroethane	--	--	LT
Toluene	3.9**	LT	8.2**
α-BHC	--	LT	LT
Acenaphthene	*	*	--
Fluoranthene	*	*	*
Naphthalene	*	*	*
Bis(2-ethylhexl) phthalate	*	*	*
Butylbenzl phthalate	--	*	--
Di-n-butyl phthalate	--	*	--
Diethyl phthalate	--	*	--
Benzo(a)anthracene	--	*	*
Benzo(a)pyrene	*	*	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	*	*
Chrysene	*	--	--
Acenaphthylene	*	*	*
Benzo(ghi)perylene	*	*	*
Fluorene	*	*	*
Dibenzo(a,h)anthracene	*	*	*
Indeno(1,2,3-cd)pyrene	--	*	*
Pyrene	*	*	*

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

** Surrogate recoveries were above or below the acceptance limits.

Table B-14.--Analyses of surface-water, ground-water and substrate samples from Tonawanda Coke, site 109, Tonawanda, N.Y. (continued)
[Locations shown in fig. B-15. Concentrations are in μg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
	Substrates		
Second sampling (5-24-83)	1A (2.0)	2A (4.0)	3A (3.0)
Organic compounds (continued)			
Nonpriority pollutants			
Carbon disulfide	2.9**	33.4	37.9**
o-Xylene	--	--	5.3**
Benzoic acid	*	--	--
2-Methylphenol	--	LT	--
Dibenzofuran	*	*	*
2-Methylnaphthalene	*	*	*
1,3-Dimethylbenzene[1]	--	--	*
1,4-Dimethylbenzene[1]	--	--	*
1-Methylnaphthalene[1]	--	--	*
1,8-Dimethylnaphthalene[1]	--	--	*
1,6,7-Trimethylnaphthalene[1]	--	--	*
7-Octadecanol[1]	--	*	--
Hexadecanol[1]	--	*	--
Hexadecanoic acid[1]	*	--	--
2-Octadecanol[1]	*	--	--
Perylene[1]	*	--	--
9-Methylphenanthrene	--	--	*
Unknown hydrocarbons[1]	*	--	*
Unknown PAH[1]			*
Compound potentially of natural origin			
2,6-Dimethylundecane[1]	--	--	*

110. TONAWANDA COKE (USGS field reconnaissance) NYSDEC 915055-c

General information and chemical-migration potential.--The Tonawanda Coke site, in the western part of the town of Tonawanda, was used as a general landfill for spent iron oxide and wood shavings during 1930-78. The rate of disposal on the site was 728 tons/yr.

All samples were taken from the fill area. The potential for contaminant migration is indeterminable.

Geologic information.--The site consists of fill overlying a glacial lacustrine clay that inturn overlies a bedrock of Camillus Shale. The U.S. Geological Survey drilled three test borings on the site in 1982; the locations are shown in figure B-15 (p. 215). The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 1.0	Coke dust and debris.
	1 - 2.0	Black organic material, water.
	2.0 - 5.0	Clay, reddish pink.
		SAMPLE: 4 ft.
2	0 - 4	Coke dust mixed with soil.
	4 - 6.5	Clay, reddish pink.
		SAMPLE: 4 ft.
3	0 - 4	Topsoil and coke debris.
	4 - 8	Coke debris, wet.
	8 - 11.5	Clay, rust colored.
		SAMPLE: 4 ft.

Hydrologic information.--Ground water was encountered at depths ranging from 2 to 8 ft below land surface. The probable direction of ground-water flow is toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected three soil samples for organic-compound analyses; results are shown in table B-15. The samples contained 27 priority pollutants and more than 18 nonpriority pollutants. The samples were held longer than the 7-day limit before organic compounds were extracted, so the concentrations may have been higher than indicated. The samples also contained 17 organic nonpriority pollutants and some unknown hydrocarbons.

Table B-15.--Analyses of substrate samples from Tonawanda Coke, site 110, Tonawanda, N.Y., May 24, 1983.
[Locations shown in fig. B-15. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1 (4.0)	(split)	2 (4.0)	3 (4.0)
Organic compounds				
Priority pollutants				
Acrolein	LT	(--)	--	--
Benzene	64.0**	(--)	3,560**	77.1**
1,1,1-Trichloroethane	LT	(10.8**)	--	3.0**
Cis,1,3-Dichloropropene	--		--	5.9**
Ethylbenzene	LT		737**	--
Methylene chloride	81.4**	(83.9**)	314**	160**
Toluene	5.97**	(21.0**)	1,420**	16.8**
Dieldrin	--	(31)	--	--
Heptachlor epoxide	22**	(--)	--	--
Acenaphthene	--	(*)	--	--
3,4-Dinitrotoluene	--	(*)	--	--
Fluoranthene	*	(*)	--	*
Naphthalene	*	(*)	--	*
N-nitrosodidiphenylamine	--	(*)	--	--
Bis(2-ethylhexl) phthalate	*	(*)	--	--
Di-n-butyl phthalate	--	(*)	--	--
Di-n-octyl phthalate	*	(--)	--	--
Benzo(a)pyrene	*	(*)	--	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	(*)	--	*
Chrysene	*	(--)	--	*
Acenaphthylene	--	(*)	--	*
Benzo(ghi)perylene	*	(*)	--	*
Fluorene	*	(*)	--	*
Phenanthrene	*	(*)	--	*
Dibenzo(a,h)anthracene	*	(*)	--	*
Indeno(1,2,3-cd)pyrene	*	(--)	--	*
Pyrene	*	(*)	--	*

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

** Surrogate recoveries were above or below the acceptance limits.

Table B-15.--Analyses of substrate samples from Tonawanda Coke, site 110, Tonawanda, N.Y., May 24, 1983 (continued)
[Locations shown in fig. B-15. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1 (4.0)	(split)	2 (4.0)	3 (4.0)
Organic compounds (continued)				
Nonpriority pollutants				
Acetone	--	(164**)	379**	--
Carbon disulfide	180**	(614**)	620**	161**
Diethyl phthalate	--	(*)	--	--
2-Hexanone	--	(--)	--	17.1**
4-Methyl-2-pentanone	--	(--)	--	6.3**
Styrene	--	(--)	86.1**	--
O-xylene	4.7**	(25.5**)	238**	17.1**
4-Chloroaniline	*	(--)	--	--
Dibenzofuran	--	(*)	--	*
2-Methylnaphthalene	*	(*)	--	*
4-Methylphenanthrene[1]	--	(*)	--	--
Tetrahydrofuran[1]	--	(--)	--	*
Perylene	--	(*)	--	--
1-Methylnaphthalene[1]	*	(--)	--	--
1,8-Dimethylnaphthalene[1]	*	(--)	--	--
Thiophene[1]	--	(--)	*	--
2-Methylbutane[1]	--	(--)	--	*
Cyclohexane[1]	--	(--)	--	*
Unknown hydrocarbons[1]	*	(*)	--	--

111. ALUMINUM MATCH PLATE CORPORATION (USGS field reconnaissance) NYSDEC 915005

General information and chemical-migration potential.--The Aluminum Match Plate Corporation site, a 1-acre area in the city of Tonawanda, was used to dispose of an unknown quantity of molding sand with phenolic binder and aluminum grindings.

The potential for the downward movement of contaminants is probably small because of the thick clay below. Chemical data give no indication of horizontal migration. The potential for contaminant migration is indeterminable.

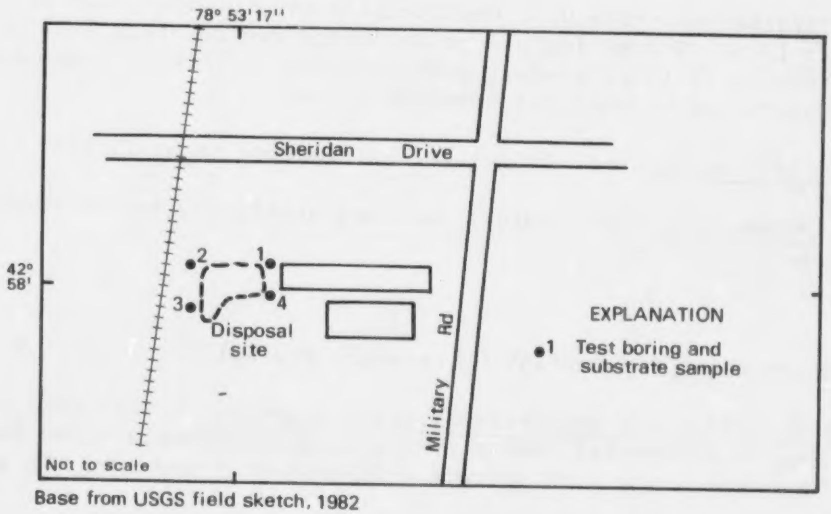
Geologic information.--The site consists of glacial lacustrine clay overlying bedrock of Camillus Shale. The shale is about 60 ft below land surface.

The U.S. Geological Survey drilled four test borings on the site in 1982; the locations are shown in figure B-16. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 1.0	Topsoil with clay cap.
	1.0 - 4.0	Clay, sandy, gray-green.
	4.0 - 8.5	Clay, red, dry.
		SOIL SAMPLE: 3.0 ft.
2	0 - 1.5	Topsoil, black.
	1.5 - 2.0	Clay, yellow.
	2.0 - 2.5	Clay, red, tight.
		SOIL SAMPLE: 1.5 ft.
3	0 - 1.5	Topsoil, black.
	1.5 - 5.0	Clay, red.
		SOIL SAMPLE: 1.5 ft.
4	0 - 2.0	Topsoil, black.
	2.0 - 5.0	Clay, red.
		SOIL SAMPLE: 1.5 ft.

Hydrologic information.--No ground water was encountered in the test borings nor in previous test drilling along Military Road (pl. 2), and no ground water was encountered to a depth of 16 ft.

Chemical information.--The U.S. Geological Survey collected four soil samples from the boreholes for iron, mercury, and phenols analyses; results are given in table B-16. Only iron was detected.



Base from USGS field sketch, 1982

Figure B-16. Location of sampling holes at Aluminum Match Plate Corporation, site 111, Tonawanda.

Table B-16.--Analyses of substrate samples from Aluminum Match Plate, site 111, Tonawanda, N.Y., July 20, 1982.
[Locations shown in fig. B-16. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1 3.0	2 1.5	3 1.5	4 1.5
Inorganic constituents				
Iron	11,000,000	13,000,000	11,000,000	8,200,000
Mercury	--	--	--	--
Organic compounds				
Phenol	--	--	--	--

114. ASHLAND PETROLEUM COMPANY (Literature review) NYSDEC 915061

General information and chemical-migration potential.--This site, in the northern part of the town of Tonawanda, is a solid-waste landfill containing spent lime, clay, wood, concrete, metal, and phosphoric acid catalysts. The potential for contaminant migration is indeterminable because data are lacking.

Geologic information.--The U.S. Geological Survey drilled four test borings on the site in 1975. The geologic logs indicated bedrock (Camillus Shale) at approximately 80 ft below grade. Overlying the bedrock is a sequence of silt and clay layers with occasional embedded gravel.

Hydrologic information.--No hydrologic information is available.

Chemical information.--No chemical data are available, and no monitoring has been proposed.

115. ASHLAND PETROLEUM COMPANY (Literature review) NYSDEC 915008c

General information and chemical-migration potential.--This site, received low-level radioactive material during 1944-46. Approximately 8,000 tons of uranium ore tailings containing 0.54 percent uranium was spread over the area to a depth of 2 ft.

No data are available to determine contaminant migration by ground-water movement. However, the chemical analyses of water from adjacent drainage ditches indicate the presence of some heavy metals and low-level radiation, which indicates possible offsite migration by surface runoff. The potential for contaminant migration in ground water is indeterminable.

Geologic information.--The site is underlain by glacial lacustrine clay of unknown thickness that in turn overlies bedrock of Camillus Shale. No geologic test borings have been made.

Hydrologic information.--No ground-water data are available. Surface water flows from the site into drainage ditches and culverts, which drain into Two Mile Creek, a tributary to the Niagara River (pl. 2).

Chemical information.--The U.S. Energy Research and Development Administration (ERDA) and the Erie County Department of Environmental Planning (ECDEP) have collected and analyzed several surface-water and soil samples.

In 1976, ERDA collected nine mud samples and eight water samples from drainage ditches upgradient and downgradient of this site. The mud samples were analyzed for uranium 238, and the water samples for radium 226, uranium 234, 235, 238, and thorium 228, 230, and 232. The results indicated low-level radiation and contamination of soils in the area.

In June 1981, ECDEP collected four water samples from the drainage ditches leading downstream from the site and analyzed them for heavy metals and selected organic compounds and tested for alpha, beta, and gamma radiation. Results supported the ERDA data, confirming the migration of low-level radiation from the site through the drainage areas. The levels of radiation in the drainage ditches are significantly below Nuclear Regulatory Commission standards.

116. ASHLAND PETROLEUM COMPANY (Literature review) NYSDEC 915008-a

General information and chemical-migration potential.--This site, in the northern part of the town of Tonawanda, was a weathering area for tetraethyl lead sludges in 1953. The area used was 10 ft x 30 ft. The site was well contained, and no leachate was present upon surficial inspection. Owner representatives indicated that lead sludge had been excavated and disposed of offsite after the lead had weathered for several years. The site probably poses no hazards, and no monitoring has been proposed. The potential for contaminant migration is indeterminable.

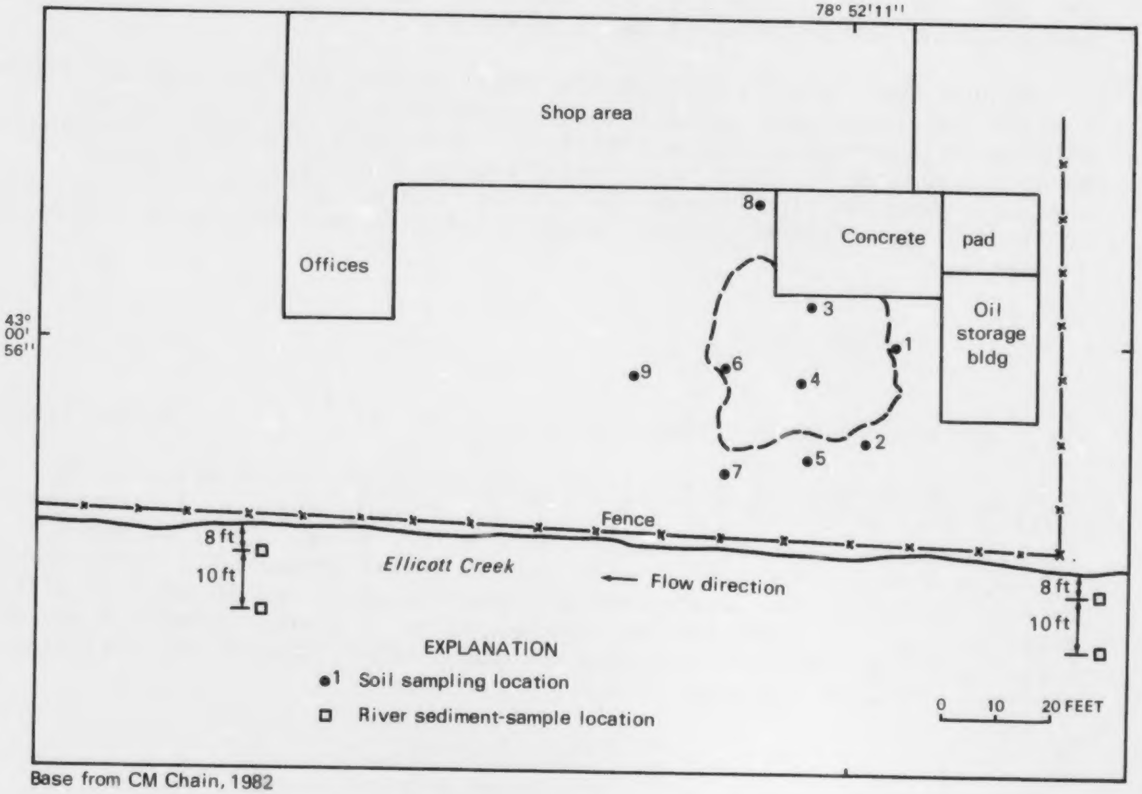
117. ASHLAND PETROLEUM COMPANY (Literature review) NYSDEC 915008-b

General information and chemical-migration potential.--This site, in the northern part of the town of Tonawanda, has been a storage pit for sediments, oil sludges, and chemical-spill recovery. The area is a concrete storage pit 280 ft wide and 220 ft long. No monitoring has been proposed for the site, and the potential for contaminant migration is indeterminable.

123. COLUMBUS MCKINNON CORPORATION (Literature review) NYSDEC 915016

General information and chemical-migration potential.--The Columbus McKinnon Corporation site, in the city of Tonawanda, was used during 1930-65 to dispose of 27,000 gallons of water-soluble waste-cutting oils in an open pit 20 ft by 20 ft adjacent to Ellicott Creek (fig. B-17). The area has since been covered with soil and graded.

The geology, direction of ground-water flow, and results of the chemical analyses indicate a major potential for contaminant migration toward Ellicott Creek, but the rate of migration has not been determined. Additional information would be needed to determine the rate of movement in both the saturated and unsaturated zone.



Base from CM Chain, 1982

Figure B-17. Location of sampling holes at Columbus McKinnon Corporation, site 123, Tonawanda.

Geologic information.--The site consists of fill overlying silt and fine sand. No deep test holes were drilled on the site, but the underlying bedrock is assumed to be Camillus Shale. Nine shallow test borings were drilled to a depth of 8 ft in 1981; all indicated only fill or fill overlying silt and fine sand.

Hydrologic information.--No information was obtained from the borehole-drilling program. However, the direction of ground-water flow is probably toward Ellicott Creek.

Chemical information.--CM Chain collected several soil samples for polychlorinated biphenyls (PCB's) and total halogenated organics (THO) analysis. Locations of the boreholes are shown in figure B-17; results are given in tables B-17 and B-18. CM Chain also collected four stream-sediment samples for PCB and THO analysis; results are given in table B-19.

Source of data.--CM CHAIN, Division Columbus McKinnon Corporation, 1982, Closure plans for inactive landfill site, Tonawanda, New York: CM Chain, 22 p., 6 tables, 3 figs.

Table B-17.--Total polychlorinated biphenyl concentration in soil samples from Colombus McKinnon Corporation, site 123, Tonawanda, N.Y.[1] [Locations are shown in fig. B-17; concentrations are in µg/kg. Dashes indicate that samples were not taken.]

Depth of sample (ft)	Borehole number								
	1	2	3	4	5	6	7	8	9
0.0	124,100	1,610	164,000	78,800	2,560	59,800	1,290	<500	125,000
0.42 - 2.0	--	--	--	459,000	--	--	--	--	--
1.0 - 1.8	--	--	--	--	201,000	--	--	--	--
.84 - 1.68	--	--	--	--	--	13,600	--	--	--
1.0 - 2.0	--	217,000	--	--	--	--	--	--	--
1.25 - 2.5	--	--	--	--	--	--	549,000	--	--
2.0 - 4.0	--	--	--	--	--	--	--	--	8,940
2.0 - 4.5	--	--	250	--	--	--	--	--	--
3.3 - 3.5	--	--	--	--	--	--	--	210	--
4.0 - 4.5	--	--	--	--	27,600	--	--	--	--
4.0 - 5.5	--	74,300	--	165,000	--	7,100	53,00	--	560
3.5 - 5.5	--	--	--	--	--	--	--	150	--
4.5 - 5.5	--	--	310	--	--	--	--	--	--
5.5 - 7.0	--	49,100	230	141,000	17,100	--	58,800	360	40
5.5 - 7.6	--	--	--	--	--	6,050	--	--	--

[1] Data from CM CHAIN, Division of Columbus McKinnon Corporation

[2] Refusal due to concrete

Table B-18.--Concentrations[1] of total halogenated organic compounds (THO) in soil samples from Columbus McKinnon Corporation, site 123, Tonawanda, N.Y.[2] (Except for borehole 1, THO was from composite of samples from each borehole).

[Locations are shown in fig. B-17. Concentrations are in μg/kg.]

Borehole number	Total halogenated organics	Borehole number	Total halogenated organics
1	14,900	6	1,200
2	14,600	7	3,400
3	4,300	8	<100
4	19,000	9	4,000
5	2,600		

[1] Total halogenated organics (THO) qualitative scan is used as an approximation of halogenated compounds based on a lindane standard curve.

[2] Data from CM CHAIN, Division of Columbus McKinnon Corporation.

Table B-19.--Concentration of polychlorinated biphenyls and total halogenated organic compounds in soil samples from Columbus McKinnon Corporation, site 123, Tonawanda, N.Y.[1] [Concentrations are in μg/kg. Locations are shown in fig. B-17.]

Sample location	Total polychorinated biphenyls	Total halogenated organics
Upstream and 5.0 ft from bank	130,000	21,300
Upstream and 15.0 ft from bank	113,000	27,400
Downstream and 5.0 ft from bank	<390	37,000
Downstream and 15.0 ft from bank	570	52,000

[1] Data obtained from CM CHAIN, Division of Columbus McKinnon Corporation.

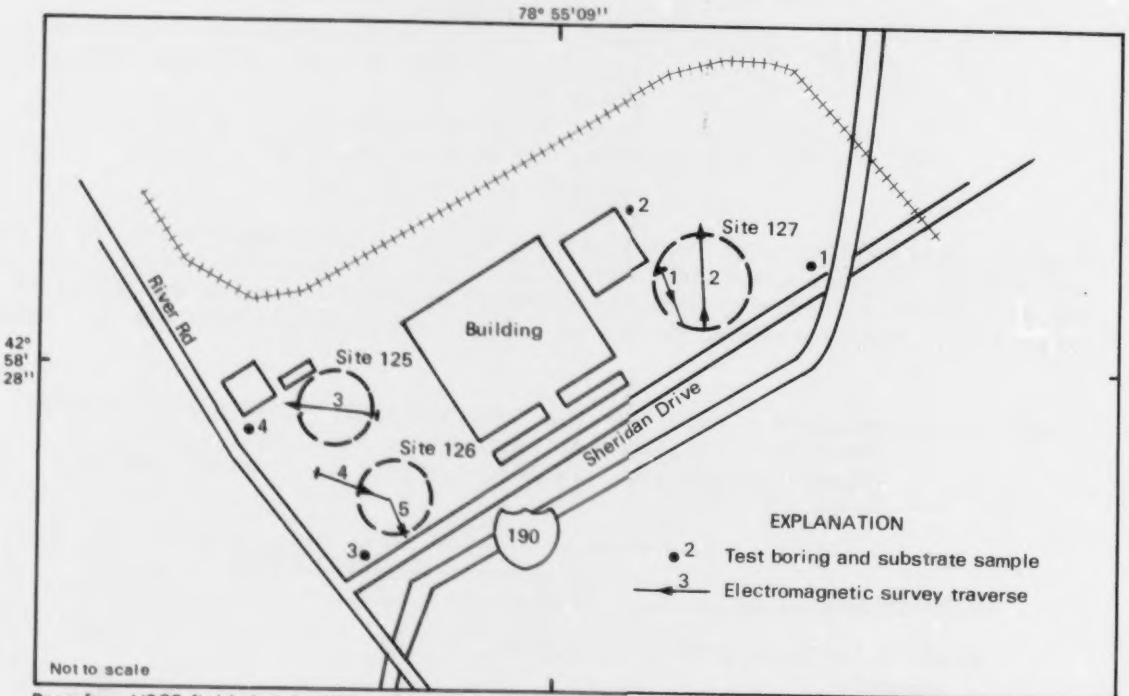
125, 126 and 127. DUNLOP TIRE & RUBBER COMPANY (USGS field reconnaissance) NYSDEC 915018a,b,c

General information and chemical-migration potential.--The Dunlop Tire and Rubber Company site, in the town of Tonawanda, consists of three disposal areas within the same property. Site 125 was a disposal site for construction and demolition material; site 126 received an unknown quantity of scrap rubber products, carbon black, sulfur, amines, and general refuse; and site 127 received coal cinders at a rate of 4,000 tons/yr during 1923-73.

The potential for vertical migration through the underlying clay to deeper units is probably limited. Additional sampling would be needed to evaluate horizontal migration of leachate from the sites. The potential for contaminant migration is indeterminable. The company has started a site investigation as a result of their chemical testing.

Geologic information.--The site consists of fill overlying a glacial lacustrine clay that overlies bedrock of Camillus Shale. The U.S. Geological Survey drilled four test borings on the site in 1982; the locations are shown in figure B-18. The geologic logs are on page 232.

Hydrologic information.--Ground water was encountered in the unconsolidated material above the unsaturated clay, which indicates a perched water table. The probable direction of ground-water flow is toward the Niagara River.



Base from USGS field sketch, 1982

Figure B-18. Location of sampling holes and electromagnetic-conductivity survey lines at Dunlop Tire and Rubber Company, sites 125, 126, and 127, Tonawanda.

Boring no.	Depth (ft)	Description
1	0 - 1.5	Dark organic soils.
	1.5 - 4.0	Same.
	4.0 - 6.5	Clay, brown, some sand, hit gravel at 6 to 6.5 ft.
	6.5 - 11.5	Clay, pinkish, dry.
	11.5 - 16.5	Same.
		SAMPLE: 1.8 ft.
2	0 - 1.5	Black organic topsoil, wet.
	1.5 - 2.0	Same.
	2.0 - 4.0	Clay, sandy, yellowish.
	4.0 - 6.5	Clay, brownish-pink.
	6.5 - 10.0	Same.
		SAMPLE: 1 ft.
3	0 - 1.0	Black organic topsoil.
	1.0 - 3.0	Black and white organic zone
	3.0 - 16.5	Clay, reddish, some sand, dry
	16.5 - 21.5	Clay.
		SAMPLE: 3 ft.
4	0 - 1.5	Brown/black organic topsoil, some rocks.
	1.5 - 4.0	Clay, reddish brown, with well-rounded and polished pebbles.
	4.0 - 6.5	Hard zone at 4 ft--went through fairly easily; hit another about 5.5 ft. Returns indicate gravel zone.
	6.0 - 11.5	Same, becoming sandy last 2 to 3 ft.
	11.5 - 17.0	Same, hit brown clay at about 17 ft.
		SAMPLE: 1.5 ft.

Chemical information.--The Geological Survey collected a soil sample from each borehole for organic-compound analysis and split each with representatives of the site owner for private analysis. The site owner's results are given in table B-20. The Geological Survey data were lost, and the site was not resampled.

Table B-20.--Analyses of soil samples from Dunlop Tire and Rubber Company, sites 125, 126, and 127, Tonawanda, N.Y., July 1982[1]
[Locations are shown in fig. B-18; concentrations are in µg/kg.]

Constituent	Sample number			
	1	2	3	4
Total volatile organic halogens	1,070	351	448	82
Total Kjedahl nitrogen	1,680,000	708,000	747,000	673,000
Phenol	188	219	194	196

[1] Data from Dunlop Tire and Rubber Company, Tonawanda, NY.

Electromagnetic survey.--The Geological Survey conducted an electromagnetic survey with five traverses in November 1982. Locations are shown in figure B-18; the data are plotted in figure B-19.

The location of line 1 is controlled primarily by the railroad tracks. Even the first 50 ft of the line are clearly within an area of artificial fill, which shows even more clearly in line 2 (p. 234). The values in the vicinity of the 250-ft mark (near 1,000 μmho/m) were the highest recorded during the entire study. Line 2 ends in the middle of the swamp and has conductivity values above those expected for uncontaminated materials, which suggests the presence of leachate.

The beginning of line 3 also shows evidence of artificial fill, but near-background values begin within 200 ft and persist for 200 ft. Beyond that point, conductivity values rise slightly.

Line 4 (p. 234) shows clear evidence of a buried conductor (probably metallic) just beyond 200 ft, beyond which is a zone of natural conductivity values. This does not necessarily mean that the ground there is uncontaminated because not all contaminants change the local conductivity. Near the parking-lot fence, the values again indicate artificial fill.

Line 5 (p. 235), run within 20 ft of the parking-lot fence, indicates buried material that differs from that along lines 3 and 4. At the 450-ft mark, conductivities are almost as high as the highest values in line 2, which suggests that the waste material underlying lines 2 and 5 may be similar.

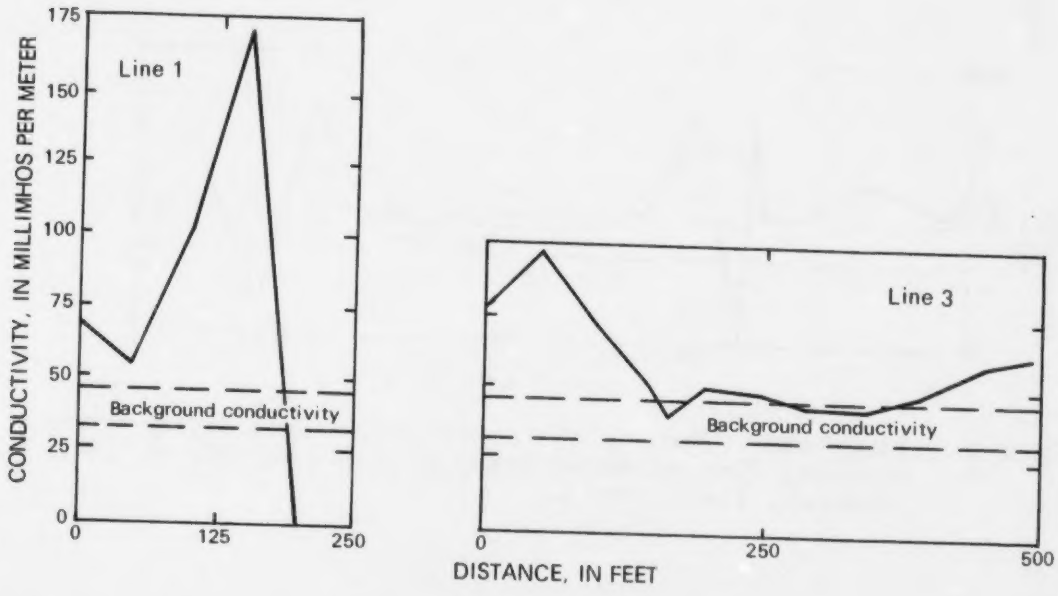


Figure B-19. Results of electromagnetic-conductivity survey at Dunlop Tire and Rubber Company, sites 125, 126, and 127, Tonawanda, lines 1 and 3.

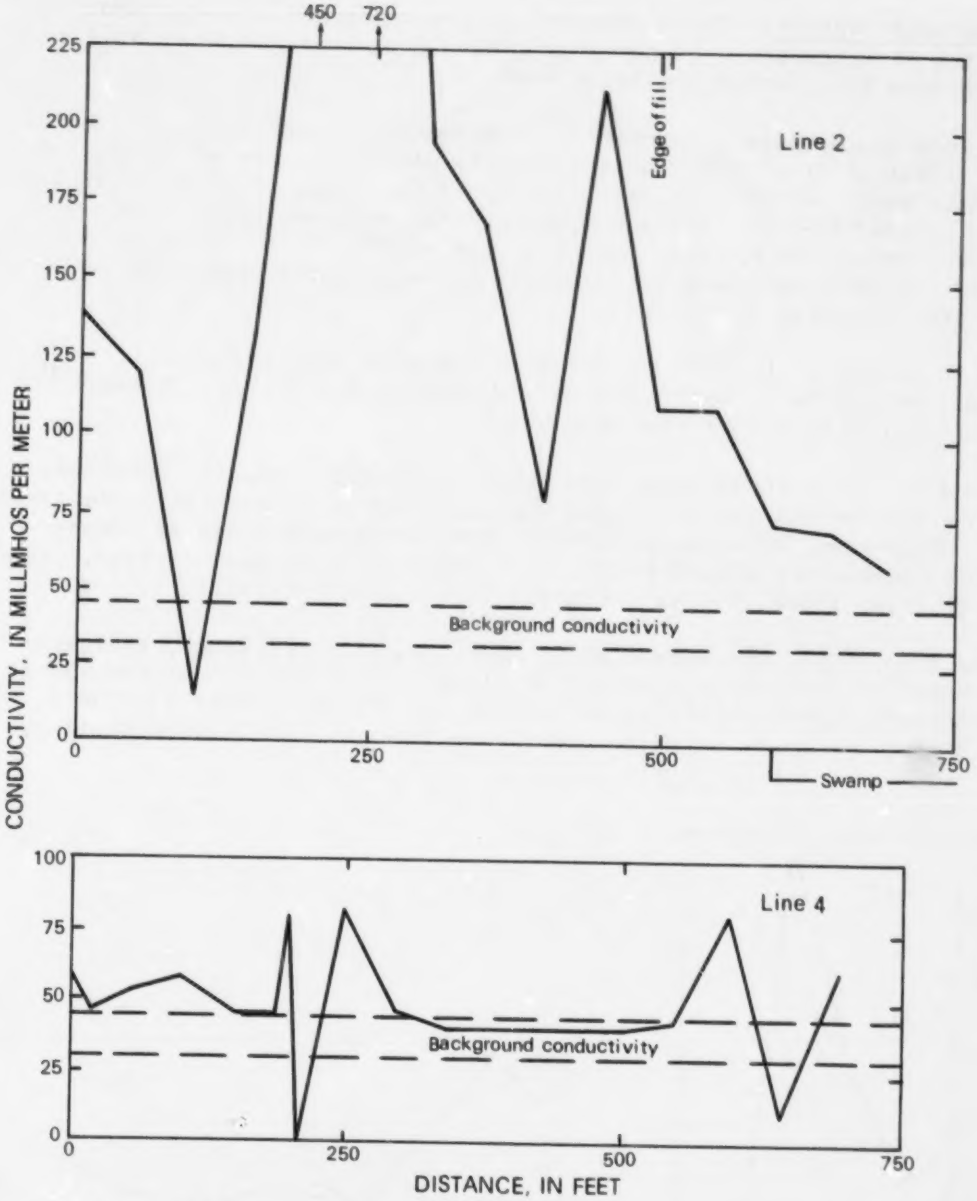


Figure B-19 (continued). Results of electromagnetic-conductivity survey at Dunlop Tire and Rubber Company, sites 125, 126, and 127, Tonawanda, lines 2 and 4.

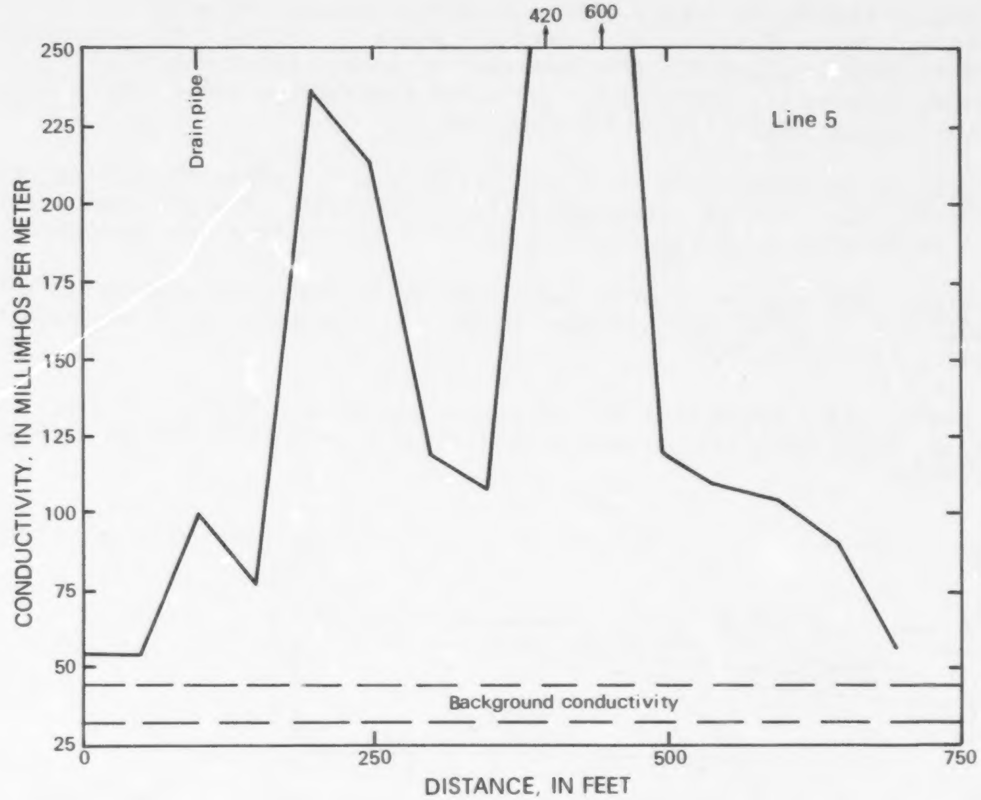


Figure B-19 (continued). Results of electromagnetic-conductivity survey at Dunlop Tire and Rubber Company, sites 125, 126, and 127, Tonawanda, line 5.

128. DUPONT COMPANY (USGS reconnaissance) NYSDEC 915019

General information and chemical-migration potential.--The Dupont Company site, in the town of Tonawanda, consists of six excavated pits that were filled with various materials during 1921-78. The types and quantity of buried material are as follows:

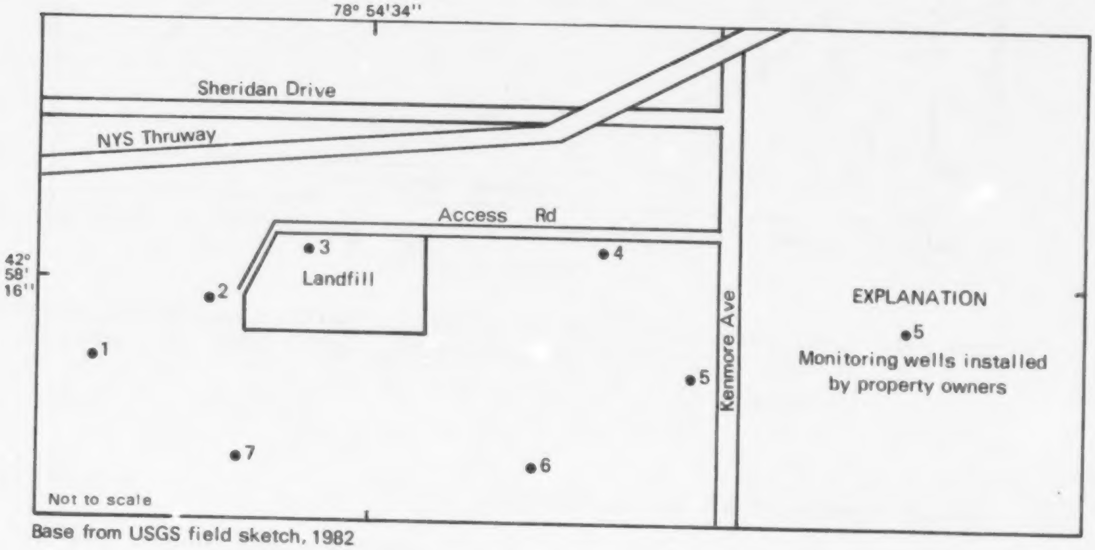
cellulosic-ulicose, rayon, cellophane, and sponges	80,000 tons
dry "Corian" waste	5,000 tons
polyvinyl alcohol film	100 tons
wet "Corian" waste	1,500 tons
"Vexar" netting	1,500 tons
dry "Tedlar" polyvinyl fluoride film	750 tons
"Tedlar" with dimethylacetamide	1,000 tons
nylon shutters and water-based paints	75 tons
miscellaneous laboratory chemicals and foundry sand from an automobile manufacturing plant	1 ton

Data collected in August 1982 indicate a limited potential for contaminant migration. No definite organic leachate plume is evident, but additional data would be needed to confirm its absence. If such a plume exists, its downward movement through the underlying clay would probably be slow. The potential for contaminant migration is indeterminable.

Geologic information.--The site consists of approximately 40 ft of glaciolacustrine clay overlying bedrock of Camillus Shale. The site owner drilled seven monitoring wells (fig. B-20), but no geologic logs are available.

Hydrologic information.--Water levels in six of the seven monitoring wells average 6.5 ft below land surface; in well 3, the water level was more than 20 ft below land surface.

Permeability tests were run on three samples of undisturbed clay. Results indicate relatively low permeability ranging from 1.08×10^{-8} to 1.60×10^{-8} cm/s.



Base from USGS field sketch, 1982

Figure B-20. Location of monitoring wells at Dupont Company, site 128, Tonawanda.

Chemical information.--Chemical analyses of water samples from monitoring wells by the site owner indicate that concentrations of sulfate, chloride, dissolved barium, dissolved lead, and dissolved mercury exceed the USEPA criterion for drinking water.

In August 1982, the U.S. Geological Survey sampled the seven wells for organic compounds; results are given in table B-21. Although no organic priority pollutants were detected, 30 nonpriority pollutants, 7 possibly naturally occurring compounds, and 1 possible artifact were detected.

Table B-21.--Analyses of ground-water samples from Dupont Company, site 128, Tonawanda, N.Y., August 18, 1982.
[Locations shown in fig. B-20. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)				
	1 (5.3)	2 (4.1)	3 (21.0)	(duplicate)	4 (5.3)
pH	7.0	7.2	7.3		6.8
Specific conductance (µmho/cm)	4,900	6,700	1,000		3,125
Temperature (°C)	15.0	17.5	12.0		16.0
Organic compounds					
Nonpriority pollutants					
3,3-dimethylbutanoic acid[1]	--	--	--	(--)	7.5
1,3-dimethylbenzene[1]	--	--	--	(--)	LT
1,4-dimethylbenzene[1]	--	--	--	(--)	LT
1,1,2-trimethylcyclohexane[1]	--	--	--	(--)	15
1,2,3-trimethylcyclohexane[1]	--	--	--	(--)	6.6
2,2-dimethylcyclohexanone[1]	--	--	--	(--)	LT
2,3-dimethylcyclohexanone[1]	--	--	--	(--)	LT
3,4-dimethyl-2-hexanone[1]	--	--	--	(--)	18
3,4,5-trimethyl-2-cyclopenten-1-one[1]	--	--	--	(--)	LT
3-methyl-(Z)-2-hexene[1]	--	--	--	(--)	LT
3-methyl-(E)-1,3,5-hexatriene[1]	--	--	--	(--)	LT
2,3,4-Trimethyl-2-cyclopenten-1-one[1]	--	--	--	(--)	120
Benzothiazole[1]	--	--	--	(--)	LT
1,1,2-trimethylcyclopropane[1]	--	--	--	(--)	11
2-[2-(2-methoxyethoxy)ethoxy] ethanol[1]	--	--	--	(--)	9.6
4-butoxybutanoic acid[1]	--	--	--	(--)	LT
2-methylbenzene sulfonamide[1]	--	--	--	(--)	11
3-ethyl-2-methyl-1,3-hexadiene[1]	--	--	--	(--)	8.1
Compounds potentially of natural origin					
3-hexanone[1]	--	--	--	(--)	LT
2-hexanone[1]	--	--	--	(--)	LT
3-methyl-cyclopentanone[1]	--	--	--	(--)	LT
Possible artifact					
4-methyl-3-hepten-2-one[1]	--	--	--	(--)	LT

---

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

Table B-21.--Analyses of ground-water samples from Dupont Company, site 128, Tonawanda, N.Y., August 18, 1982 (continued)
[Locations shown in fig. B-20. Concentrations are in μg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
	5 (6.0)	6 (5.4)	7 (3.9)
pH	6.8	6.9	7.0
Specific conductance (μmho/cm)	1,680	700	6,600
Temperature (°C)	18.0	6.0	16.5
Organic compounds			
Nonpriority pollutants			
Bis-2,2'[methylenebis(oxy)] butane[1]	5	--	--
Phenol,2-methoxy,acetate[1]	LT	--	--
1-1(1,1'-dimethylethoxy)-4-methoxybenzene[1]	14	--	--
2,6-dimethyl-4-heptanone[1]	--	6	--
1-(1,1'-dimethlethyl)-4-methylbenzene[1]	--	5	--
2,6,10,15-tetramethylheptadecane[1]	--	7	--
2-methylbenzenamine[1]	--	--	185
Trans-4-chlorocyclohexanol[1]	--	--	21
1,3,3-trimethylbicyclo-[2.2.1]heptan-2-one[1]	--	--	12
1,7,7-trimethylbicyclo-[2.2.1] heptan-2-one[1]	--	--	7
1,3-Dihydro-2H-imidazo-[4,5-b]pyridin-2-one[1]	--	--	LT
Compounds potentially of natural origin			
Octacosane[1]	--	8	--
Hexacosane[1]	--	8	--
Tridecane[1]	--	LT	--
Hydrocarbon[1]	-	LT	--
5,7-dimethylundecane[1]	--	7	--

130. EXOLON CORPORATION (Literature review) NYSDEC 915023

General information and chemical-migration potential.--The Exolon Company, on East Niagara Street in the City of Tonawanda, manufactures aluminum oxide and silicon carbide abrasives for grinding wheels and general industrial use. The company was reported to have disposed of refractory bricks, iron tailings, and coal cinders in a low area of approximately 1.5 acres.

The potential for contaminant migration is indeterminable from the data available.

Geologic information.--The soils are lacustrine silt, sand, and clay deposits. The site has one well, which is reported to be 140 ft deep. Information provided by the site owner indicates the following geologic log:

Depth (ft)	Description
0 - 4	sandy loam
4 - 80	clay and silt
80 - 86	sand
86 - 140	bedrock (Camillus Shale)

Hydrologic information.--Ground-water data are scant. Depth to water has been reported to be approximately 4 ft. The water table probably fluctuates seasonally during spring and other wet periods. Horizontal flow would be greatest during these periods, particularly in the sandy loam. The direction of flow would probably be northward toward the Erie-Barge Canal. Ground water could flow vertically through the sandy loam but would be impeded by the deeper clay and silt layer.

Chemical information,--No chemical information is available, and no monitoring has been planned.

131. FMC CORPORATION (USGS field reconnaissance)

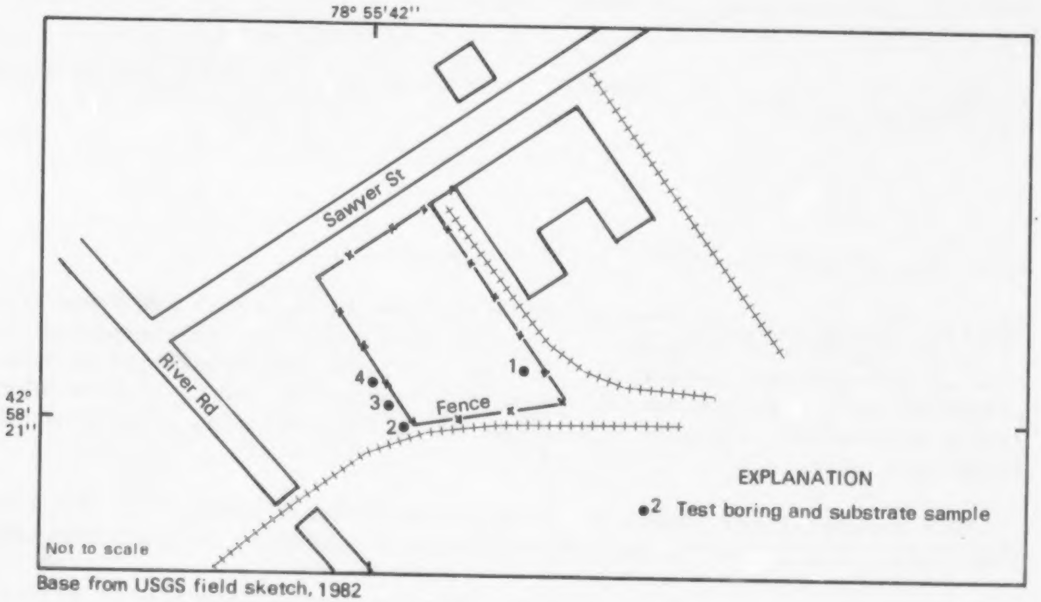
General information and chemical-migration potential.--The FMC Corporation site, in the town of Tonawanda, contains disposal pits for approximately 100 tons of persulfates, perborates, sodium carbonate peroxide, hydrogen peroxide, peracetic acid, calcium and zinc peroxide, magnesium, urea, pyrophosphate, and dipicolinic acid. The site was in operation from 1964-76. The pits have since been closed.

The potential for downward migration is probably limited by the underlying clay unit. The potential for offsite lateral migration is indeterminable.

Geologic information.--The site consists of a glacial lacustrine deposit overlying bedrock of Camillus Shale. The depth to bedrock is greater than 60 ft.

The Geological Survey drilled four test borings in 1982; the locations are shown in figure B-21. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 0.5	Topsoil.
	0.5 - 6.5	Clay, reddish, dry, tight.
		Note: Moved forward and took 0.5 sample with hand auger.
2	0 - 2.0	Clay, red, "cap"?
	2.0 - 3.0	Sand, some clay, dark green, wet.
	3.0 - 11.5	Clay, reddish.
		SAMPLE: 2.5 ft.
3	0 - 2.5	Clay, red, some fill and gravel.
	2.5 - 3.5	Clay, dark green, some sand, damp.
	3.5 - 6.5	Clay, red, dry, tight.
		SAMPLE: 2.0 ft?
4	0 - 2.5	Clay, red.
	2.5 - 3.0	Clay, dark green.
	3.0 - 3.5	Clay, red, tight. Hit hard material at 3.5 ft.
		SAMPLE: 2.5 ft.



Base from USGS field sketch, 1982

Figure B-21. Location of sampling holes at FMC Corporation, site 131, Tonawanda.

Hydrologic information.--No ground water was encountered in the test borings. The moist material encountered in borehole 2 can be attributed to a buried water main that was leaking at the time of drilling.

Chemical information.--The U.S. Geological Survey collected a substrate sample from each borehole for iron and zinc analysis in 1982 and for organic compounds in 1983. Results are given in table B-22. The samples contained 18 organic priority pollutants, 23 organic nonpriority pollutants, and some unknown hydrocarbons.

Table B-22.--Analyses of substrate samples from FMC, site 131, Sawyer Street, Tonawanda, N.Y.
[Locations shown in fig. B-21. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
First sampling (08-04-82)	1 (0.5)	2 (2.5)	3 (2.5)	4 (2.5)
Inorganic constituents				
Iron	160,000	470,000	410,000	370,000
Zinc	1,000	17,000	29,000	13,000

	Sample number			
Second sampling (08-19-83)	1A	2A	3A	4A
Inorganic constituents				
Molecular sulfur	--	10,000	--	--
Organic compounds				
Priority pollutants				
Acenaphthene	*	*	*	*
Fluoranthene	*	*	*	*
Naphthalene	*	*	*	--
Bis(2-ethylhexl) phthalate	*	--	--	*
Di-n-butyl phthalate	--	*	--	--
Di-n-octyl phthalate	--	--	--	*
Benzo(a)anthracene	*	*	*	*

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified--Holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

Table B-22.--Analyses of substrate samples from FMC, site 131, Sawyer Street, Tonawanda, N.Y. (continued)
[Locations shown in fig. B-21. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number			
Second sampling (08-19-83)	1A	2A	3A	4A
Organic compounds (continued)				
Priority pollutants (continued)				
Benzo(a)pyrene	*	*	*	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	--	*	*
Chrysene	*	*	*	*
Acenaphthylene	*	--	--	--
Anthracene	*	*	*	--
Benzo(ghi)perylene	*	*	*	*
Fluorene	*	*	*	--
Phenanthrene	*	*	*	--
Dibenzo(a,h)anthracene	*	*	*	*
Indeno(1,2,3-cd)pyrene	*	*	*	*
Pyrene	*	*	*	*
Nonpriority pollutants				
Dibenzofuran	*	*	*	*
2-Methylnaphthalene	*	*	*	--
Benzoic acid	--	*	*	--
1-Methylnaphthalene[1]	*	--	--	--
Dibenzothiophene[1]	*	--	--	--
Acridine[1]	*	--	--	--
Phenanthridine[1]	*	--	--	--
9H-carbazole[1]	*	--	*	--
9-Methylphenanthrene[1]	*	--	--	--
3-Methylphenanthrene[1]	*	--	--	--
4-Methylphenanthrene[1]	*	--	--	--
7-Methyl-9H-carbazole[1]	*	--	--	--
1-Phenylnaphthalene[1]	*	--	--	--
9,10-Anthracenedione[1]	*	--	--	--
9-Ethylphenanthrene[1]	*	--	--	--
2,5-Dimethylphenanthrene[1]	*	--	--	--
1-Methylpyrene[1]	*	*	*	--
7-Methylbenzo(a) anthracene[1]	*	--	*	--
4-Cyclopenta(def) phenanthrene[1]	*	--	--	--
Perylene	--	--	*	--
Hexadecanoic acid[1]	--	--	*	--
4-Hydroxy-3-methoxybenzaldehyde[1]	--	--	*	--
4H-Cyclopenta(def) phenanthrene[1]	--	--	*	--
Unknown hydrocarbons[1]	*	*	*	--

136. INS EQUIPMENT CORPORATION (USGS field reconnaissance) NYSDEC 915031

General information and chemical-migration potential.--The INS Equipment Corporation site, in the City of Tonawanda, contains 55 acres and was used to dispose of an unknown quantity of pit sludge, cutting oils, grinding waste, and foundry sand. The site has since been covered, graded, and seeded.

This site has a major potential for contaminant migration to the Niagara River. The proximity of the site to the river, the probable direction of ground-water flow, the chemical results, and the former wetland character of the site together suggest that migration could be occurring.

Geologic information.--Before the site was graded and seeded, it consisted of wetlands and glacial lacustrine deposits. The underlying bedrock is Camillus Shale.

The U.S. Geological Survey drilled 10 test borings on the site 1982; locations are shown in figure B-22. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 1.5	Topsoil.
	1.5 - 14.5	Black foundry sand, asphaltic smell, debris, rubble. Hit hard zone at 14 ft; could barely drill 6 inches more.
		SAMPLE: 14 ft.
2	0 - 15.0	Black and gray zones of foundry sand, debris. Hit hard zone at 15 ft.
		SAMPLE: 15 ft.
3	0 - 18.0	Black foundry sands, debris.
	18.0 - 18.5	Gravel and pebbles.
	18.5 - 21.5	Sand, black, wet.
	21.5 - 26.5	Clay, gray-green.
		SAMPLE: 18.5 ft.
4	0 - 16.5	Black foundry sands, cinder ash debris.
	16.5 - 19.5	Same but saturated.
	19.5 - 21.5	Clay, gray-green.
		SAMPLE: 16.5 ft.
5	0 - 6.5	Black foundry sands, dry.
	6.5 - 11.5	Same, with rubble and gravel.
	11.5 -16.5	Same with nuts, bolts, rubber hoses, wood, metal bindings, wet at 15 ft.
		SAMPLE: 15 ft.
6	0 - 6.5	Foundry sand, black to brown, medium.
	6.5 - 11.5	Same, rubble at 10 - 11.5.
	11.5 - 16.5	Sand, brown to black, rubble, hard drilling, no returns.
	16.5 - 21.5	No returns, gray-green sandy clay on bit.
		SAMPLE: 20 ft.

136. INS EQUIPMENT CORPORATION (USGS field reconnaissance) NYSDEC 915031

General information and chemical-migration potential.--The INS Equipment Corporation site, in the City of Tonawanda, contains 55 acres and was used to dispose of an unknown quantity of pit sludge, cutting oils, grinding waste, and foundry sand. The site has since been covered, graded, and seeded.

This site has a major potential for contaminant migration to the Niagara River. The proximity of the site to the river, the probable direction of ground-water flow, the chemical results, and the former wetland character of the site together suggest that migration could be occurring.

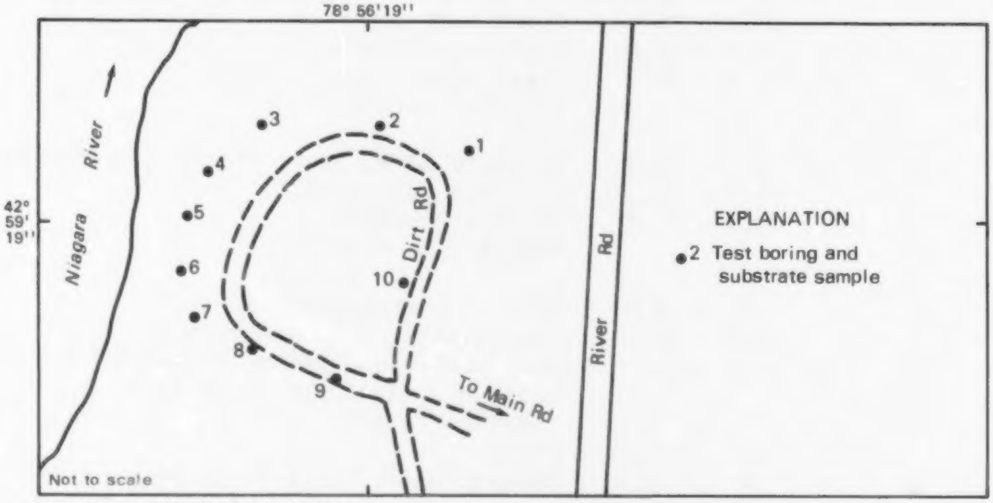
Geologic information.--Before the site was graded and seeded, it consisted of wetlands and glacial lacustrine deposits. The underlying bedrock is Camillus Shale.

The U.S. Geological Survey drilled 10 test borings on the site 1982; locations are shown in figure B-22. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 1.5	Topsoil.
	1.5 - 14.5	Black foundry sand, asphaltic smell, debris, rubble. Hit hard zone at 14 ft; could barely drill 6 inches more. SAMPLE: 14 ft.
2	0 - 15.0	Black and gray zones of foundry sand, debris. Hit hard zone at 15 ft. SAMPLE: 15 ft.
3	0 - 18.0	Black foundry sands, debris.
	18.0 - 18.5	Gravel and pebbles.
	18.5 - 21.5	Sand, black, wet.
	21.5 - 26.5	Clay, gray-green. SAMPLE: 18.5 ft.
4	0 - 16.5	Black foundry sands, cinder ash debris.
	16.5 - 19.5	Same but saturated.
	19.5 - 21.5	Clay, gray-green. SAMPLE: 16.5 ft.
5	0 - 6.5	Black foundry sands, dry.
	6.5 - 11.5	Same, with rubble and gravel.
	11.5 -16.5	Same with nuts, bolts, rubber hoses, wood, metal bindings, wet at 15 ft. SAMPLE: 15 ft.
6	0 - 6.5	Foundry sand, black to brown, medium.
	6.5 - 11.5	Same, rubble at 10 - 11.5.
	11.5 - 16.5	Sand, brown to black, rubble, hard drilling, no returns.
	16.5 - 21.5	No returns, gray-green sandy clay on bit. SAMPLE: 20 ft.

Boring no.	Depth (ft)	Description
7	0 - 8.0	Slag on top, then foundry sand, then limestone--could not drill. SAMPLE: 8 ft.
8	0 - 9.0	Topsoil, brown to black, slag, debris, gravel, hard drilling.
	9 - 15.0	Gravel, gray and pea rock. Could not drill through. SAMPLE: 14 ft.
9	0 - 0.5	Black cinder ash.
	0.5 - 4.0	"Iron ore" with gravel, could not drill through. SAMPLE: 4 ft.
10		Note: Moved twice to get around hard zone at 1.0 ft. Tried again--still drilling in fresh wood. Fourth try:
	0 - 1.5	Topsoil and wood.
	1.5 - 4.0	Sand, dark brown to black, gravel, could not drill through. SAMPLE: 4 ft.

Hydrologic information.--Ground water was encountered in two of the 10 boreholes at depths of 15 and 18 ft below land surface. Past history of the site indicated that some areas were wetlands. The direction of ground-water flow is probably westward toward the Niagara River.



Base from USGS field sketch, 1982

Figure B-22. Location of sampling holes at INS Equipment Corporation, site 136, Tonawanda.

Chemical information.--The Geological Survey collected a soil sample at each borehole within the disposal area for cadmium, chromium, iron, lead, and organic-compound analyses; results are given in table B-23. The concentrations of cadmium, chromium, and lead were higher than in samples from undisturbed areas not affected by waste-disposal sites. The samples contained 19 organic priority pollutants, most in concentrations above 10,000 ug/kg and one as high as 150,000 ug/kg (fluoranthene in hole 9); 15 organic nonpriority pollutants and 14 possibly naturally occurring organic compounds also were found. Ground-water quantity was insufficient for sampling.

Table B-23.--Analyses of substrate samples from INS Equipment Corporation, site 136, Tonawanda, N.Y., August 10, 1982.
[Locations shown in fig. B-22. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.)

	Sample number and depth below land surface (ft)				
	1 (14.0)	2 (15.0)	3 (20.0)	4 (16.5)	5 (15.0)
Inorganic constituents					
Cadmium	53,000††	20,000††	--	5,000††	6,000††
Chromium	430,000††	70,000††	3,000	30,000††	180,000††
Iron	100,000,000	26,000,000	3,700,000	16,000,000	41,000,000
Lead	2,500,000††	630,000††	10,000	110,000††	170,000††
Organic compounds	***	***	***	***	***
Priority pollutants					
Phenol	61,000	--	--	--	--
Naphthalene	LT	--	--	--	LT
Acenaphthalene	LT	--	--	--	LT
Fluorene	LT	--	--	--	--
Phenanthrene	41,000	--	LT	LT	33,000
Anthracene	LT	--	--	--	--
Fluoranthene	25,000	--	--	--	--
Pyrene	18,000	--	--	--	17,000
Di-n-butyl phthalate	LT	--	--	--	11,000
Benzo(a)anthracene	LT	--	--	--	LT
Chrysene	LT	--	--	--	LT
Bis(2-ethylhexl) phthalate	52,000	--	LT	--	5,000
2,4-dimethylphenol	LT	--	--	--	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. The concentration reported is semi-quantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from undisturbed soils in the Tonawanda area. Undisturbed soils not analyzed for iron.

***Analyzed at detection limit above that required by this study.

Table B-23.--Analyses of substrate samples from INS Equipment Corporation, site 136, Tonawanda, N.Y., August 10, 1982 (continued) [Locations shown in fig. B-22. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.)

	Sample number and depth below land surface (ft)				
	1 (14.0)	2 (15.0)	3 (20.0)	4 (16.5)	5 (15.0)
Organic compounds (continued)					
Nonpriority pollutants					
Dibenzofuran	--	--	--	--	LT
O-cresol	11,000	--	--	--	--
P-cresol	43,000	--	--	LT	--
2-Methylnaphthalene	LT	--	--	--	LT
2,4-Dimethyl-1,3-dioxolane[1]	30,000	--	--	--	--
1,3-Dimethylbenzene[1]	5,200	--	--	--	--
Decane[1]	25,000	--	--	--	--
Undecane[1]	55,000	--	--	--	--
Tridecane[1]	90,000	--	23,000	--	26,000
Tetradecane[1]	270,000	13,000	--	--	82,000
Hexadecane[1]	305,000	--	64,000	--	--
Heptadecane[1]	160,000	--	--	--	600,000
Octadecane	310,000	--	--	--	550,000
Eicosane[1]	188,000	--	--	--	570,000
Hexicosane[1]	97,000	--	--	--	--
2,6,10,14-Tetramethylheptadecane[1]	88,000	--	--	--	63,000
4-Methyldecane[1]	7,300	--	--	--	--
Dodecane[1]	--	--	5,300	--	--
2,6,11-Trimethyldodecane[1]	--	--	8,700	--	--
Pentadecane[1]	--	--	--	--	260,000
2-Methylpentadecane[1]	--	--	--	--	49,000

	Sample number and depth below land surface (ft)				
	6 (20.0)	7 (8.0)	8 (14.0)	9 (4.0)	10 (4.0)
Inorganic constituents					
Cadmium	1,000	4,000	1,000	2,000	2,000
Chromium	7,000	120,000††	30,000††	20,000	120,000††
Iron	6,000,000	29,000,000	2,900,000	25,000,000	19,000,000
Lead	30,000	120,000††	30,000	130,000††	100,000
Molecular sulfur[1]	--	--	44,000	--	--

Table B-23.--Analyses of substrate samples from INS Equipment Corporation, site 136, Tonawanda, N.Y., August 10, 1982 (continued) [Locations shown in fig. B-22. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.)

	Sample number and depth below land surface (ft)				
	6 (20.0)	7 (8.0)	8 (14.0)	9 (4.0)	10 (4.0)
Organic compounds	**	**	**	**	**
Priority pollutants					
Bis(2-ethylhexyl) phthalate	--	LT	--	--	--
Fluorene	--	--	--	13,000	--
Phenanthrene	--	--	--	70,000	--
Anthracene	--	--	--	26,000	--
Fluoranthene	--	--	--	150,000	--
Pyrene	--	--	--	88,000	--
Benzo(a)anthracene	--	--	--	47,000	--
Chrysene	--	--	--	35,000	--
Benzo(a)pyrene	--	--	--	23,000	--
Indeno(1,2,3-cd)pyrene	--	--	--	LT	--
Dibenzo(a,h)anthracene	--	--	--	LT	--
Benzo(g,h,i)perylene	--	--	--	LT	--
Benzo(b)fluoranthene	--	--	--	33,000	--
Benzo(k)fluoranthene	--	--	--	33,000	--
Acenaphthylene	--	--	--	21,000	--
Nonpriority pollutants					
Dibenzofuran	--	--	--	12,000	--
2-Methylnaphthalene	--	--	--	LT	--
Benzo(k)phenanthrene[1]	--	--	--	6,000	--
Perylene[1]	--	--	--	16,000	--
1,5-Hexadiyne[1]	30,000	--	--	--	--
Cyclohexane[1]	11,000	--	--	--	--
3-Hexen-2-one[1]	4,900	--	--	--	--
4-Methylphenanthrene[1]	--	--	--	18,000	--
2-Phenylnaphthalene[1]	--	--	--	7,100	--
1-Methylpyrene[1]	--	--	--	9,500	--
7-H-Benzo(DE) anthracene-7-one[1]	--	--	--	17,500	--
Hexadecane[1]	--	2,500	--	--	--

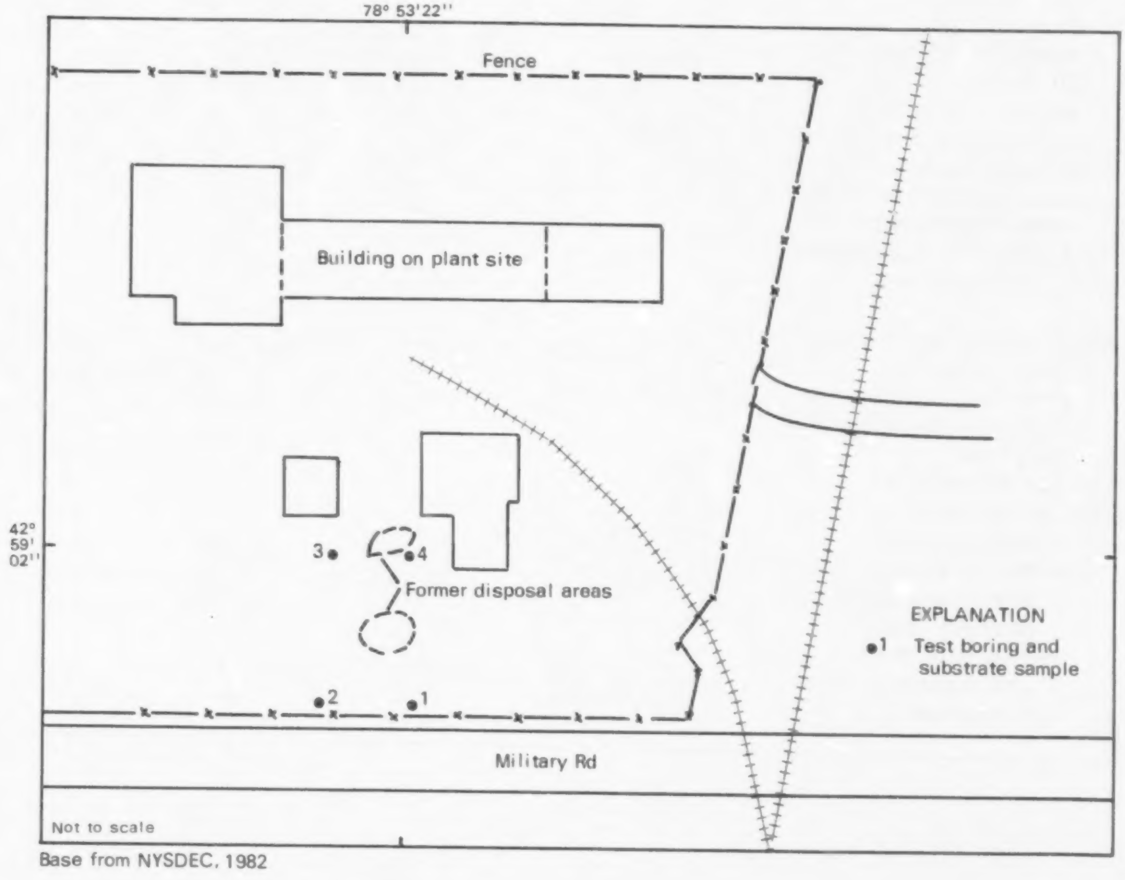
137. PENNWALT-LUCIDOL DIVISION (USGS field reconnaissance) NYSDEC 915035

General information and chemical-migration potential.--The Pennwalt-Lucidol Division, in the town of Tonawanda, was used to dispose of phosphorus acid sludge and limestone during 1956-70 at a rate of 62.5 tons/yr. The material has since been removed.

The potential for downward movement of contaminants is probably limited by the clay unit. Additional information would be needed to confirm lateral migration; therefore, the potential for offsite migration is indeterminable.

Geologic information.--The site consists of glacial lacustrine clay overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled four test borings on the site in 1982; the locations are shown in figure B-23. The geologic logs are on page 249.

Hydrologic information.--No ground water was encountered.



Base from NYSDEC, 1982

Figure B-23. Location of sampling holes at Pennwatt-Lucidol Division, site 137, Tonawanda.

Boring no.	Depth (ft)	Description
1	0 - 2.0	Fill, gray to brown.
	2.0 - 3.0	Clay, rusty brown.
	3.0 - 11.5	Clay, red, dry.
		SAMPLE: 2 ft.
2	0 - 1.5	Fill, black topsoil.
	1.5 - 3.0	Black, loose dirt, fill, rocky.
	3.0 - 4.0	Clay, rusty brown as in borehole.
	4.0 - 6.5	Clay, rusty brown to clay, red, tight.
		SAMPLE: 3 ft.
3	0 - 2.0	Topsoil and gravel.
	2.0 - 3.5	Black, organic, "slushy" material, pea gravel.
	3.5 - 4.0	Clay, brown, sandy, dry.
	4.0 - 6.5	Clay, reddish.
		SAMPLE: 3 ft.
4	0 - 1.0	Topsoil, reddish.
	1.0 - 3.0	Black, damp, organic material, gravel.
	3.0 - 4.0	Clay, greenish, damp.
	4.0 - 5.0	Clay, reddish.
		SAMPLE: 2.5 ft.

Chemical information.--The Geological Survey collected four soil samples for organic-compound analyses; results are shown in table B-24. The samples contained seven organic priority pollutants; concentrations ranged from 930 to 3,260 μg/kg.

Table B-24.--Analyses of substrate samples from Pennwatt-Lucidol Division, site 137, Tonawanda, N.Y., July 30, 1982.
[Locations shown in fig. B-23. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1 (2.5)	2 (3.0)	3 (3.0)	4 (2.5)
Organic compounds				
Priority pollutants				
Fluoranthene	--	1,440	2,010	--
Pyrene	--	1,190	2,350	--
Benzo(a)anthracene	--	1,060	903	--
Chrysene	--	1,400	1,510	--
Benzo(b)fluoranthene	--	1,880	--	1,052
Benzo(k)fluoranthene	--	3,260	--	--
Benzo(a)pyrene	--	--	--	911
Possible artifact				
4-methyl-3-penten-2-one	LT	--	--	--

143. O-CEL-O PRODUCTS (Literature review)

General information and chemical-migration potential.--O-CEL-O Products, on Sawyer Avenue in the city of Tonawanda, consists of a settling pond to hold sulfur sludge. An aqueous sulfur slurry from the process buildings is pumped to the pond, and the residual in the pond is a sulfur sludge that was recovered and sold. The amount of sulfur sludge produced is reported to be 75,000 gal/yr. Before the settling pond was put into service, the sludge was removed by a sewer discharging to the Town of Tonawanda wastewater-treatment facility.

The potential for contaminant migration is indeterminable because data are lacking.

Geologic information.--The site owners had five test borings drilled on the property in 1974--four to a depth of 10.5 ft; the fifth to 30.5 ft. The four shallow borings indicate the same material from 0 to 10.5 ft. The geologic log for the deepest boring is as follows:

Depth (ft)	Description
0 - 2	Gray-brown medium silt and clay
2 - 16.5	Gray-brown hard silty clay with embedded pebbles, occasional lenses of fine sand and silt.
16.5 - 30.5	Moist brown medium silty clay, trace of embedded fine gravel.

Hydrologic information.--Water was not encountered in any of the borings. Upon completion of the deepest boring, water was poured into the hole to fill it. The water level dropped 0.3 ft within 4 hours, indicating a low permeability for the screened zone.

Chemical information.--No chemical data for this site are available, and no monitoring has been proposed.

149. ROBLIN STEEL COMPANY (USGS field reconnaissance) NYSDEC 915036

General information and chemical-migration potential.--The Roblin Steel Company site, in the western part of the town of Tonawanda, was used to dispose of 1 Mgal of sulfuric acid pickling liquor and 300,000 to 400,000 tons of foundry sand. The liquor was disposed of in 1969-70, and the foundry sand during 1964-71.

The permeable river deposits and the proximity of the site to the Niagara River suggest a large potential for contaminant migration from this site; however, the chemical data are limited and migration of contaminants cannot be confirmed; therefore, the potential for offsite migration is considered indeterminable.

Geologic information.--The site consists of topsoil overlying river deposits of sand and gravel. The U.S. Geological Survey drilled one test hole in 1982. The geologic descripton is as follows:

Depth (ft)	Description
0 - 4.5	Topsoil and gravel fill.
4.5 - 5.5	Dark-brown sand with river gravel (polished and rounded), wet.
5.5 - 6.5	Sand, greenish, gravel, saturated. SAMPLE: 6 ft.

Hydrologic information.--Ground water was encountered 5 ft below land surface. The direction of ground-water flow is westward toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected a substrate sample from the borehole at a depth of 6 ft for arsenic, cadmium, chromium, copper, iron, lead, mercury, and zinc analyses; results are shown in table B-25. The concentration of cadmium, chromium, copper, lead, and zinc exceeded those in undisturbed soils not affected by waste-disposal practices.

Table B-25.--Analyses of substrate sample at 6-ft depth from Roblin Steel, site 149, Tonawanda, N.Y., August 10, 1982. [Concentrations are in µg/kg; dash indicates constituent not found.]

Inorganic constituents	Concentration
Arsenic	--
Cadmium	6,000††
Chromium	80,000††
Copper	52,000††
Iron	32,000,000
Lead	180,000††
Mercury	--
Zinc	440,000††

†† Exceeds concentrations in samples taken from undisturbed soils in the Tonawanda area.

150, 151. SHANCO PLASTICS AND CHEMICALS (USGS field reconnaissance) NYSDEC 915048

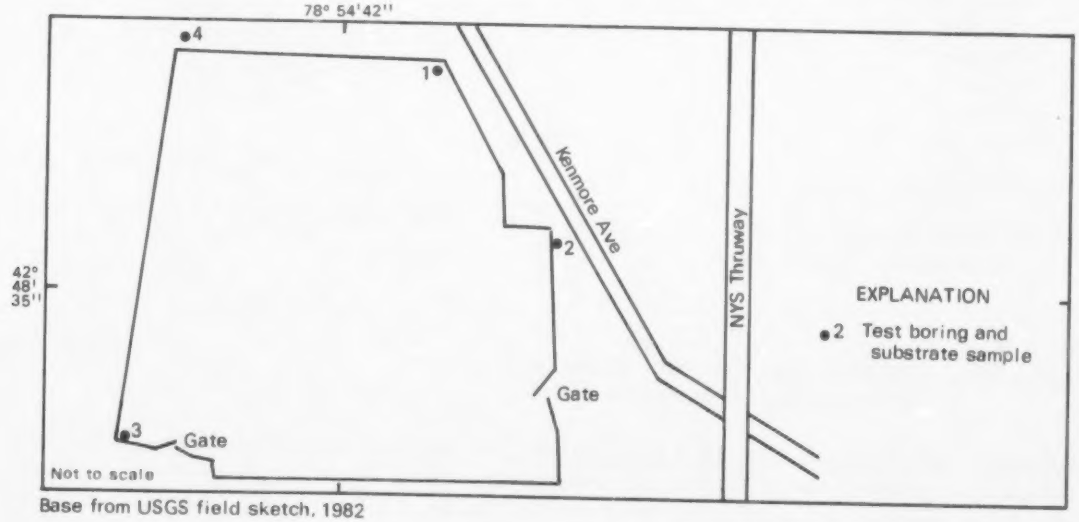
General information and chemical-migration potential.--The Shanco Plastics and Chemicals sites, in the town of Tonawanda, were used to dispose of phenols and phenolic resins at a rate of 80 tons/yr until 1976. Also, unknown amounts of polymerizers, carbolic acids, and drums of chemical wastes were deposited. The drums have since been removed for proper disposal. The sites are now inactive, and little is known about past burial practices or removal of contaminated soils. The potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled four test borings in 1983; the locations are shown in fig. B-24. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 3.5	Topsoil.
	3.5	Clay
		SAMPLE: 3.5
2	0 - 2.0	Topsoil.
	2.0	Clay.
		SAMPLE: 2.0
3	0 - 3.0	Fill.
	3.0	Clay, red.
		SAMPLE: 3.0
4	0 - 4.0	Fill, black.
	4.0	Clay, red
		SAMPLE: 4.0

Hydrologic information.--No hydrologic data are available.

Chemical information.--The U.S. Geological Survey took four substrate samples from the site in May 1983 for organic-compound analyses. The samples contained four organic priority pollutants, three of which were below the quantifiable detection limit. Phenol concentration in sample 1 was 170,000 µg/kg. The samples also contained two organic nonpriority pollutants, seven possibly naturally occurring organic compounds, and some unknown hydrocarbons; results are shown in table B-26.



Base from USGS field sketch, 1982

Figure B-24. Location of sampling holes at Shanco Plastics and Chemicals, sites 150 and 151, Tonawanda.

Table B-26.--Analyses of substrate samples from Shanco Plastics, sites 150 and 151, Tonawanda, N.Y., May 31, 1983.
[Locations shown in fig. B-24. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1 (3.5)	2 (2.0)	3 (3.0)	4 (4.0)
Inorganic constituents				
Molecular sulfur[1]	--	--	--	3,000
Organic compounds				
Priority pollutants				
Phenol	170,000	--	LT	--
Naphthalene	LT	--	--	--
Fluoranthene	--	--	LT	--
Pyrene	--	--	LT	--
Nonpriority pollutants				
1,2,3,4,4A,9,10,10A-Octahydro-1,4A-dimethyl-7-isopropyl-1-phenanthrene carboxylic acid, methylester[1]	100,000	--	--	--
Fenchone[1]	200	--	--	--
Dodecane[1]	200,000	--	--	--
Tridecane[1]	400,000	--	--	--
Tetradecane[1]	500,000	--	--	--
Pentadecane[1]	500,000	--	--	--
Hexadecane[1]	500,000	--	--	--
Heptadecane[1]	400,000	--	--	--
Octadecane[1]	200,000	--	--	--
Unknown hydrocarbons[1]	400,000	--	--	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

153. SPAULDING FIBRE COMPANY NYSDEC 915050a-d
(USGS field reconnaissance and literature review)

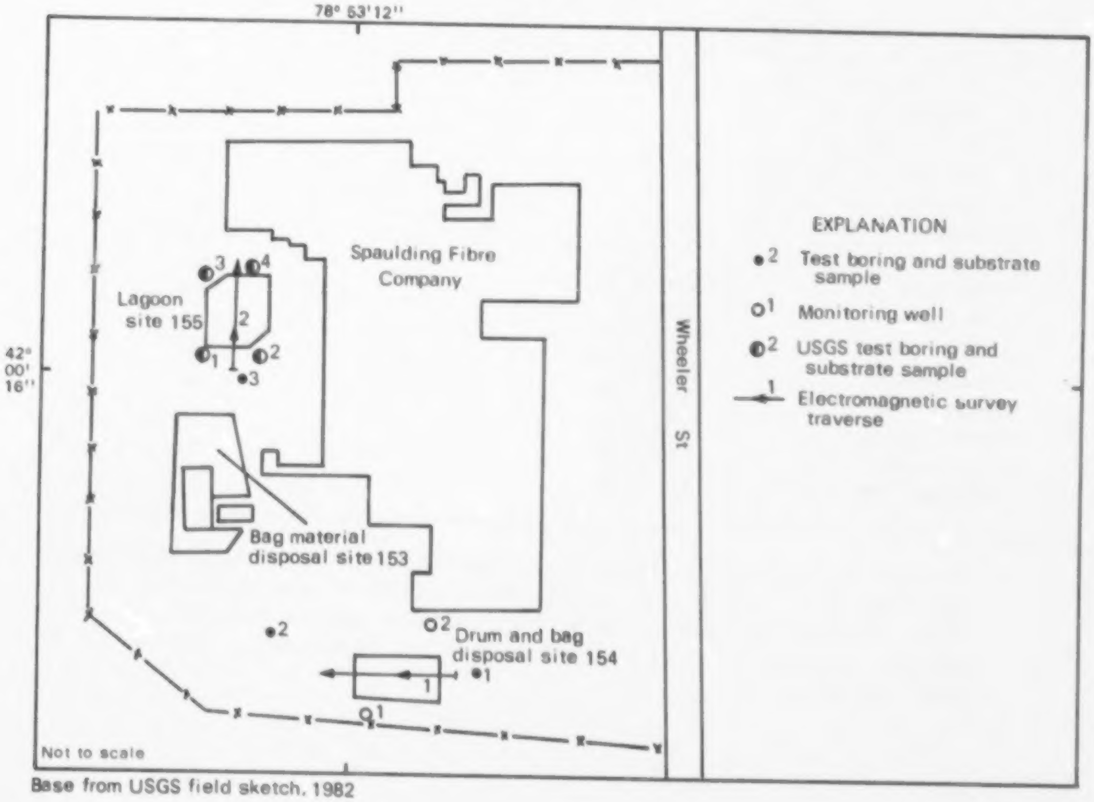
General information and chemical-migration potential.--The Spaulding Fibre Company site, in the city of Tonawanda, contains four disposal sites:

Site 153 was used for the disposal of 20 tons of asbestos and fiberglass resin dust during 1977-78.

Site 154 was a disposal site for approximately 750 drums of waste varnishes.

Site 155a,b contain several lagoons that were used to collect grinding wastes containing phenol and zinc chlorides. The sludge that collected in these lagoons has been excavated and the lagoons filled with clean material. The site has now been properly closed.

The potential for vertical migration through the underlying clay unit appears limited. Horizontal migration of contaminants is possible during periods of intense preciptation, but additional data would be needed to confirm leachate migration. Thus, the potential for contaminant migration is indeterminable until more data become available.


78° 53'12''
42° 00' 16''
Spaulding Fibre Company
Lagoon site 155
3
4
2
1
2
3
Bag material disposal site 153
2
2
Drum and bag disposal site 154
1
1
1
Wheeler St
Not to scale
EXPLANATION
•2 Test boring and substrate sample
○1 Monitoring well
◐2 USGS test boring and substrate sample
1 Electromagnetic survey traverse

Base from USGS field sketch, 1982

Figure B-25. Location of sampling holes, monitoring wells, and electromagnetic-conductivity survey lines at Spaulding Fibre Company, sites 153, 154, 155a, and 155b, Tonawanda.

Geologic information.--Earth Dimensions, Inc. drilled three geologic test borings on sites 154 and 155 in 1978 (Krehbiel Associates, 1978); the locations are shown in fig. B-25. The geologic logs indicate clayey lake sediments overlying a silty clay till. These units vary in thickness within the site. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - .5	Moist, reddish-brown silty clay fill, very firm.
	.5 - 4	Extremely moist to wet black cinders, reddish-brown silty-clay and industrial waste, very friable to firm.
	4 - 4.5	Moist, reddish-brown silty clay with less than 5 percent gravel.
	4.5 - 20	Moist, reddish-brown, silty clay loam with 5 to 10 percent subangular, gray, hard shale and dolomitic gravel.
2	0 - .5	Extremely moist, black, cinder fill, very friable.
	.5 - 1	Moist, black, silty loam topsoil.
	1 - 2	Moist, mottled, reddish-brown silty clay with gray vertical desiccation cracks.
	2 - 14	Moist, reddish-brown silty clay loam with 10 to 15 percent subangular hard dolomite and shale gravels and occasional cobbles.
	14 - 20	Moist, brown, silty clay loan with 10 to 15 percent subangular hard dolomite and shale gravel.
3	0 - .5	Moist, black, silt loam topsoil, very friable.
	.5 - 3	Moist, distinctly mottled, reddish-brown, silty clay with gra desiccation cracks.
	3 - 6	Moist, reddish-brown heavysilt loam, thinly bedded.
	6 - 12.5	Moist, reddish-brown silty clay loam with 10 to 15 percent subangular, hard, gray shale and dolomite gravels.
	12.5 - 20	Moist to extremely moist, brown silty clay loam with 10 to 15 percent subangular, gray hard shale and dolomite gravels.

The U.S. Geological Survey drilled four test borings at site 155 in 1982; the locations are shown in figure B-25. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 0.5	Topsoil.
	0.1 - 3.5	Clay, red, mixed with gravel, extremely tight. SOIL SAMPLE: 2 - 3.5 ft.

Boring no.	Depth (ft)	Description
2	0 - 5.5	Clay, red, tight, dry, with layers of gravel.
	5.5 - 7.0	Clay, red, wet.
	7.0 - 11.5	Clay, red, tight, dry.
	11.5 - 16.5	Clay, red, tight, dry.
		SOIL SAMPLE: 5.5 - 7.0 ft.
3	0 - 5.0	Clay, reddish, tight, dry, some gravel.
	5.0 - 5.5	Clay, reddish, wet.
	5.5 - 26.5	Clay, reddish, dry.
		SOIL SAMPLE: 5 - 5.5 ft.
4	0 - 0.5	Topsoil.
	0.5 - 3.5	Clay, reddish, tight, dry.
	3.5 - 4.5	Clay, reddish, damp.
	4.5 - 16.5	Same as above but with gravel layers.
		SOIL SAMPLE: 3.5 - 4.5 ft.

Hydrologic information.--Hydrologic data are reported in Krehbiel Associates (1978) and in Calspan Corporation (written commun., 1979). The Calspan Corporation ran permeability tests on undisturbed cores from the three test borings from site 154.

A study by Dunn Geoscience Corporation indicates the direction of groundwater flow to be northward from the site (Krehbiel Associates, 1978). Calspan Corporation calculated permeability coefficients from six undisturbed cores from the three test borings; results are given in table B-27.

Chemical information.--Two monitoring wells were installed on the site. One well is upgradient from the disposal area, the other is downgradient. Samples were analyzed for chemical oxygen demand, phenol, and antimony; results are

Table B-27.--Permeability coefficients from test borings at Spaulding Fibre Company, sites 154 and 155, Tonawanda, N.Y.[1]

[Locations are shown in fig. B-25.]

Test boring	Sample zone (ft below land surface)	Permeability coefficient (cm/s)
1	4.5 - 5.5	$k = 1.06 \times 10^{-7}$
	15 - 17	$k = 2.1 \times 10^{-7}$
2	5 - 6	$k = 2.0 \times 10^{-5}$
	15 - 17	$k = 2.3 \times 10^{-7}$
3	3.5 - 4.5	$k = 2.2 \times 10^{-5}$
	14.5 - 15.5	$k = 1.4 \times 10^{-6}$

[1] Tests by Calspan Corporation.

given in table B-28. The highest phenol concentration was 230 µg/L. The Geological Survey also collected a soil sample from each borehole at the lagoon (site 155a,b) for iron, zinc, and phenol analyses; results are given in table B-29. No phenols were found, and zinc concentrations did not exceed those in undisturbed soils not affected by waste-disposal practices.

Electromagnetic survey.--The U.S. Geological Survey conducted an electromagnetic survey on sites 154 and 155 in November 1982. Two lines were run. The locations are shown in fig. B-25; the data are plotted in fig. B-26.

Line 1 was in an open field south of the main plant on site 154. All measurements within 120 ft of the disposal-area mound show the effects of artificial fill. Buried metal is strongly indicated at several points along the traverse (15 ft, 100 ft, 200 ft, and 400 ft). The final two data points along line 1 may represent background values, but additional data would be needed to confirm this.

Line 2, northwest of line 1, was run over site 155. No large deviation from background conductivity is evident except at the 200-ft mark; the cause of this decrease is unknown.

Source of data.--Krehbiel Associates, Inc., 1978, Industrial solid waste management facility for Spaulding Fibre Co., Inc., Unpublished report to site owner, 17 p., 3 figs., 1 pl.

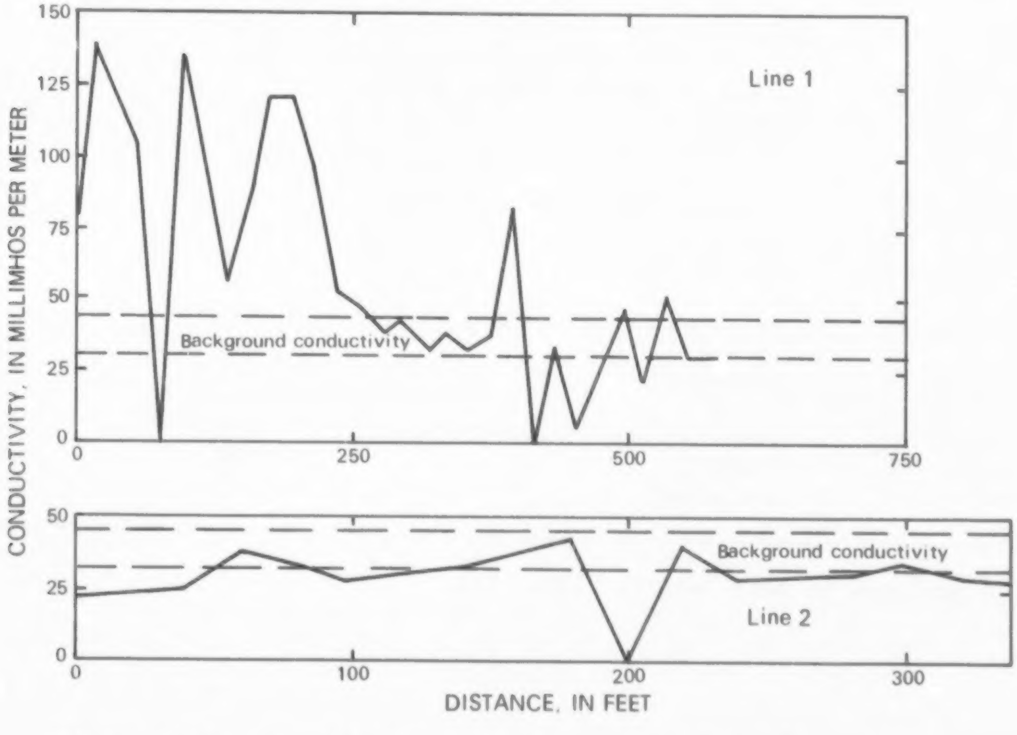


Figure B-26. Results of electromagnetic-conductivity survey at Spaulding Fibre, site 154 and 155, Tonawanda. (Locations are shown in fig. B-25.)

Table B-28.--Analyses of water from monitoring wells at Spaulding Fibre Company, site 154, Tonawanda, N.Y.[1], 1979-81
[Well locations are shown in fig. B-25. Concentrations are in μg/L except where indicated .]

Date	Constituent	Well 1 (upgradient)	Well 2 (downgradient)
11-23-78	chemical oxygen demand (mg/L)	175	89
	phenol	<250	100
	antimony	<10	10
1-25-79	chemical oxygen demand (mg/L)	78	59
	phenol	220	90
	antimony	<10	<10
8-18-79	chemical oxygen demand (mg/L)	26.5	49.1
	phenol	40	30
	antimony	<100	<100
9-20-79	chemical oxygen demand (mg/L)	24.4	50.1
	phenol	150	80
	antimony	<5	<5
12-20-79	chemical oxygen demand (mg/L)	19.8	32.2
	phenol	70	80
	antimony	<5	<5
5-15-80	chemical oxygen demand (mg/L)	7.9	19.9
	phenol	230	190
	antimony	<1	<1
10-23-80	chemical oxygen demand (mg/L)	18.8	55.6
	phenol	<30	<30
	antimony	<2	<2
3-26-81	chemical oxygen demand (mg/L)	7.7	11.5
	phenol	210	260
	antimony	<5	<5
12-10-81	chemical oxygen demand (mg/L)	<5	<5
	phenol	<30	<30
	antimony	<2	<2

---

[1] Analyses by Acts Testing Labs., Inc.

Table B-29.--Analyses of substrate samples from Spaulding Fibre, site 155, Tonawanda, N.Y., July 21, 1982.
[Locations shown in fig. B-25. Concentrations are in µg/kg. Sample 4 was not analyzed.]

	Sample number and depth below land surface (ft)			
	1 (3.2)	2 (5.5)	3 (5.0)	4 (5.0)
Inorganic constituents				
Iron	9,400,000	5,200,000	7,000,000	
Zinc	38,000	41,000	37,000	

158. UNION CARBIDE, LINDE DIVISION (Literature review) NYSDEC 915038

General information and chemical-migration potential.--The Union Carbide Linde Division site, in the town of Tonawanda, was used as a storage site for uranium tailings during 1942-48. A report by the U.S. Department of Energy (1978) states that the radiation standards were being met. However, 72,000 yd^3 of soil was contaminated with low-level radiation, and 19,000 yd^3 of building material in and around five buildings used in processing the uranium were contaminated. In addition, approximately 50 Mgal of liquid waste containing small amounts of a radioactive residual from the production of U_3O_8 concentrate was pumped into wells on the property that discharge to the Camillus Shale.

According to a Department of Energy report (1981), the data from a survey by the Department of Energy:

> ...clearly demonstrated that the concentrations of radionuclides in ground water were well below the levels established by the Nuclear Regulatory Commission as acceptable for release to an unrestricted area. Due to the very high natural mineral content of the ground water, it is not acceptable as drinking water or for many other industrial or residential uses; hence, no significant pathway exists for exposure of the general public.

Thus, the potential for contaminant migration is indeterminable.

Geologic information.--The site consists of a glaciolacustrine clay overlying bedrock of Camillus Shale. The shale lies about 95 ft below land surface.

Hydrologic information.--Ground water was reported at 1 to 1.5 ft below land surface during site construction. This probably represents a perched water table above the clay unit.

Chemical information.--No chemical data are available.

Source of data.--U.S. Department of Energy, 1981, Evaluation of liquid effluent discharge from the Linde Air Products Company Ceramics Plant: U.S. Department of Energy, Executive Summary, 10 p.

160. J. H. WILLIAMS COMPANY (USGS field reconnaissance) NYSDEC 915057

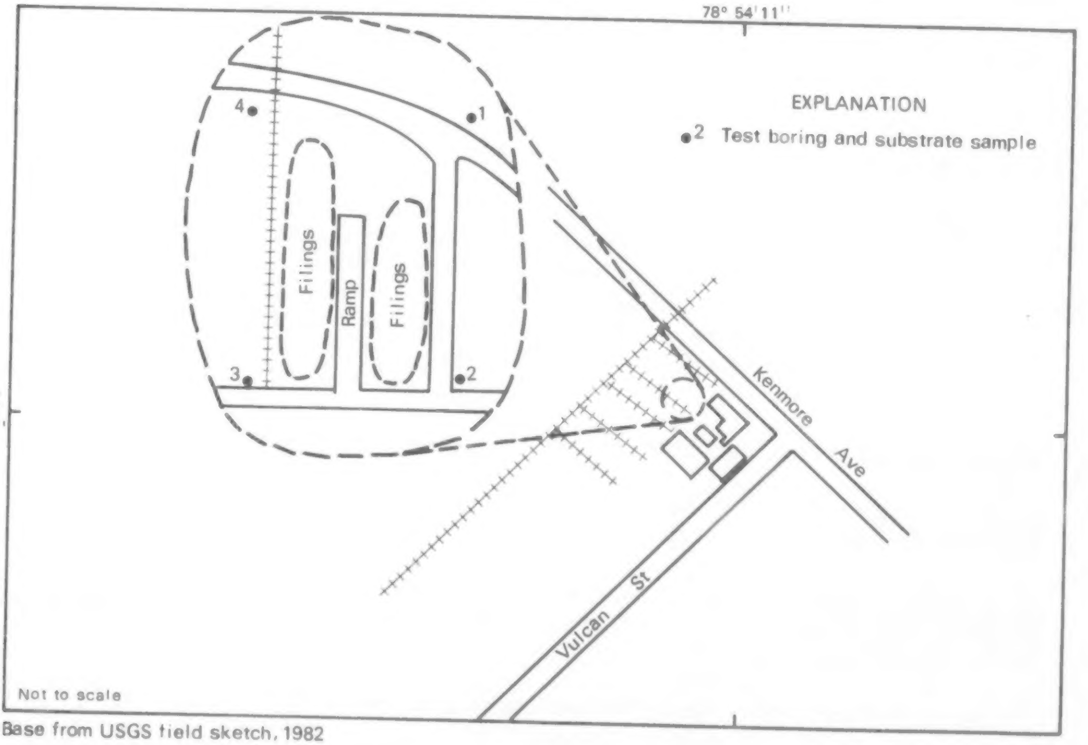
General information and chemical-migration potential.--The J. H. Williams Company site, in the City of Tonawanda, contained two small areas where oils and solvents were disposed of. The soils have since been excavated and removed.

The potential for downward migration is probably limited by the underlying clay unit. Preliminary sampling indicates the presence of organic priority pollutants and a possiblity of horizontal migration, but until additional testing is done, the potential for contaminant migration is indeterminable.

Geologic information.--The site consists of a glacial lacustrine clay overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled four test borings on the site in 1982; the locations are shown in figure B-27. The geologic logs are on page 261.

Hydrologic information.--No ground water was encountered in the boreholes.

Chemical information.--The U.S. Geological Survey collected a soil sample from each borehole for iron, lead, and organic-compound analyses; results are given in table B-30. Concentratons of lead in sample 2 exceeded those in samples from undisturbed sites not affected by waste-disposal practices.



Base from USGS field sketch, 1982

Figure B-27. Location of sampling holes at J. H. Williams Company, site 160, Tonawanda.

Sample 4 contained seven organic priority pollutants, all in concentrations above 3,400 µg/kg. The fill encountered at borehole 4 indicates that the sample may be from within the disposal area.

Boring no.	Depth (ft)	Description
1	0 - 1.5	Topsoil, dark brown.
	1.5 - 3.5	Clay, gray-green to red-brown.
	3.5 - 10.5	Clay, red.
		SAMPLE: 2 ft.
2	0 - 1.5	Topsoil, black, organic, not very damp.
	1.5 - 3.5	Clay, greenish gray.
	3.5 - 6.5	Clay, reddish, dry, tight.
		Note: Moved back and took sample at 2 ft.
3	0 - 1.5	Topsoil.
	1.5 - 2.0	Clay, gray-green, sandy, "mushy".
		SAMPLE: 1.5 ft.
4	0 - 1.5	Topsoil, black, fill.
	1.5 - 2.0	Clay, gray-green, sandy.
	2.0 - 6.5	Clay, red.
		SAMPLE: 1.5 ft.

Table B-30.--Analyses of substrate samples from J. H. Williams, site 160, Tonawanda, N.Y., July 29, 1982.
[Locations shown in fig. B-27. Concentrations are in µg/kg.)

	Sample number and depth below land surface (ft)			
	1 (2.0)	2 (2.0)	3 (1.5)	4 (1.5)
Inorganic constituents				
Iron	8,000,000	13,000,000	12,000,000	15,000,000
Lead	20,000	360,000††	100,000	60,000
Organic compounds	***	***	***	
Priority pollutants				
Phenanthrene	--	--	--	3,760
Fluoranthene	--	--	--	3,580
Pyrene	--	--	--	4,120
Benzo(a)anthracene	--	--	--	3,410
Chrysene	--	--	--	4,520
Benzo(b)fluoranthene	--	--	--	4,180
Benzo(k)fluoranthene	--	--	--	5,180

†† Exceeds concentrations in samples taken from undisturbed soils in the Tonawanda area.

***Analyzed at detection limit above that required by this study.

167. CHEMICAL LEAMAN TANK LINES (USGS reconnaissance) NYSDEC 915014

General information and chemical-migration potential.--The Chemical Leaman Tank Lines site, in the city of Tonawanda, consists of three unlined settling ponds that are used to hold drained tanker residue for offsite disposal to the Tonawanda sewer system.

Geologic and chemical data indicate a possibility for contaminant migration, but the potential is indeterminable. Ground-water samples contained several organic compounds that could be associated with past disposal operations.

Geologic information.--The Anderson Drilling Company drilled four test borings in 1981. The drilling logs indicate that the site consists of fill overlying a fine silty sand approximately 15 ft thick and underlain by a soft red clay. The borings did not reach bedrock, which is probably Camillus Shale.

Table B-31.--Analyses of ground-water samples from Chemical Leaman Tank Lines, site 167, Tonawanda, N.Y., July 19, 1982.
[Concentrations are in µg/kg; dashes indicate that compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
	1 (8.1)	2 (8.7)	3 (11.6)
pH	6.9	7.0	7.4
Specific conductance (µmho/cm)	1,496	2,400	1,400
Temperature (°C)	11.0	11.0	11.0
Organic compounds			
Priority pollutant			
Phenol	--	LT	38†
Nonpriority pollutants			
3,4-Dichlorobenzoic acid[1]	780	--	--
4-(1,1-Dimethylethyl)phenol[1]	--	--	62
1-(2-Butoxyethoxy)ethanol[1]	690	--	--
Compounds potentially of natural origin			
1-Hexanol[1]	--	--	60
2-Methyl-2-propanol[1]	13	--	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

Hydrologic information.--Ground water was encountered at depths of 8 to 12 ft below land surface. The direction of ground-water flow is southward toward Ellicott Creek.

Chemical information.--The U.S. Geological Survey collected water samples from three monitoring wells downgradient from the settling ponds along the southern boundary of the property. Each sample was analyzed for organic compounds; results are given in table B-31. Phenol concentrations in samples from well 3 exceed the USEPA criterion for drinking water and the NYS ground-water standard. No other priority pollutants were found.

182. HUNTLEY POWER STATION (USGS field reconnaissance) NYSDEC 915063

General information and chemical-migration potential.--The Huntley Power Station site, also known as the "Cherry Farm" area, in the town of Tonawanda, was reportedly used by Occidental Chemical-Durez for the disposal of approximately 625 tons of phenol tars, some of which contained varying amounts of chlorinated benzenes. An unknown amount of foundry sand and slag was also disposed of on the site.

The potential for contaminant migration is major. Preliminary results of organic-compound analyses indicate the presence of unknown quantities of priority pollutant compounds. Heavy-metal data indicate that lead has migrated through the fill into the sand unit below. Geologic logs indicate that all substrate samples were collected from within disposal areas; therefore additional data would be needed to evaluate horizontal migration toward the Niagara River.

Geologic information.--The unconsolidated layers consist of glacial lacustrine sand, silt, and clay overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled 13 test borings on the site in 1982; the locations are shown in figure B-28. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 19	Black cinder ash, wet at about 11 ft.
	19 - 26.5	Sand, gray, fine, "soupy." SAMPLE: 26.5 ft.
2	0 - 10	Cinder ash, black. Hit rocks at 10 ft; could not drill through. Moved inland 50 ft, could not drill through again, moved 50 ft further inland.
	0 - 15	Cinder ash, black.
	15 - 16.5	Sand, fine, gray, "soupy." SAMPLE: 15 ft.
3	0 - 26.5	Cinder ash, black. Probably hit gray/green sand at 20 ft, but hole was so large that no returns came to surface. SAMPLE: Took sample from auger stem at 20 ft.

Boring no.	Depth (ft)	Description
4	0 - 20	Cinder ash, black, wet at 11 ft.
	20 - 21.5	Sand, gray, wet.
		SAMPLE: 18 ft.
5	0 - 22	Cinder ash, black.
	22 - 26.5	Sand, gray-green, wet.
		SAMPLE: 22 ft.
6	0 - 18	Cinder ash, black.
	18 - 26.5	Sand, gray-green, wet.
		SAMPLE: 18 ft.
7	0 - 15	Fly ash, black.
	15 - 19	Sand, brown, wet.
	19 - 26.5	Sand, gray-green, wet.
		SAMPLE: 19 ft.
8	0 - 17	Fly ash, brownish color at about 11 ft, wet.
	17 - 26.5	Sand, gray-green. Much water in hole but could not make a well.
		SAMPLE: 17 ft.
9	0 - 21	Cinder ash, black. Hit exceptionally hard zone about 14 ft. Boulder?
	21 - 26.5	Sand, gray-green, wet.
		SAMPLE: 21 ft.
10	0 - 21.5	Fly ash, black. Hard drilling, but not rocks, at 10 ft. At 12 ft started to get rock sound - no returns. Started to move faster at 13 ft, but rock sound still present--must be loose rocks in large borehole or cavity. Various debris coming out; metal strapping, springs, rubber gloves, etc. Strong benzene odor. Swept with HNU volatiles detection: metal strappings give reading 12 times background.
		SAMPLE: 21 ft
11	0 - 10	Fly ash, black. Hit boulders at 10 ft and could not drill through. Moved 50 ft inland.
	0 - 21	Fly ash, black.
	21 - 26.5	Sand, gray-green, wet.
		SAMPLE: 21 ft.
12	0 - 21	Fly ash, black, brown, rusty colored layer at 10 ft.
	21 - 26.5	Sand, gray-green, wet.
		SAMPLE: 21 ft.
13	0 - 20	Fly ash, black; brown zone at about 11 ft.
	20 - 26.5	Sand, gray-green, wet.
		SAMPLE: 20 ft.

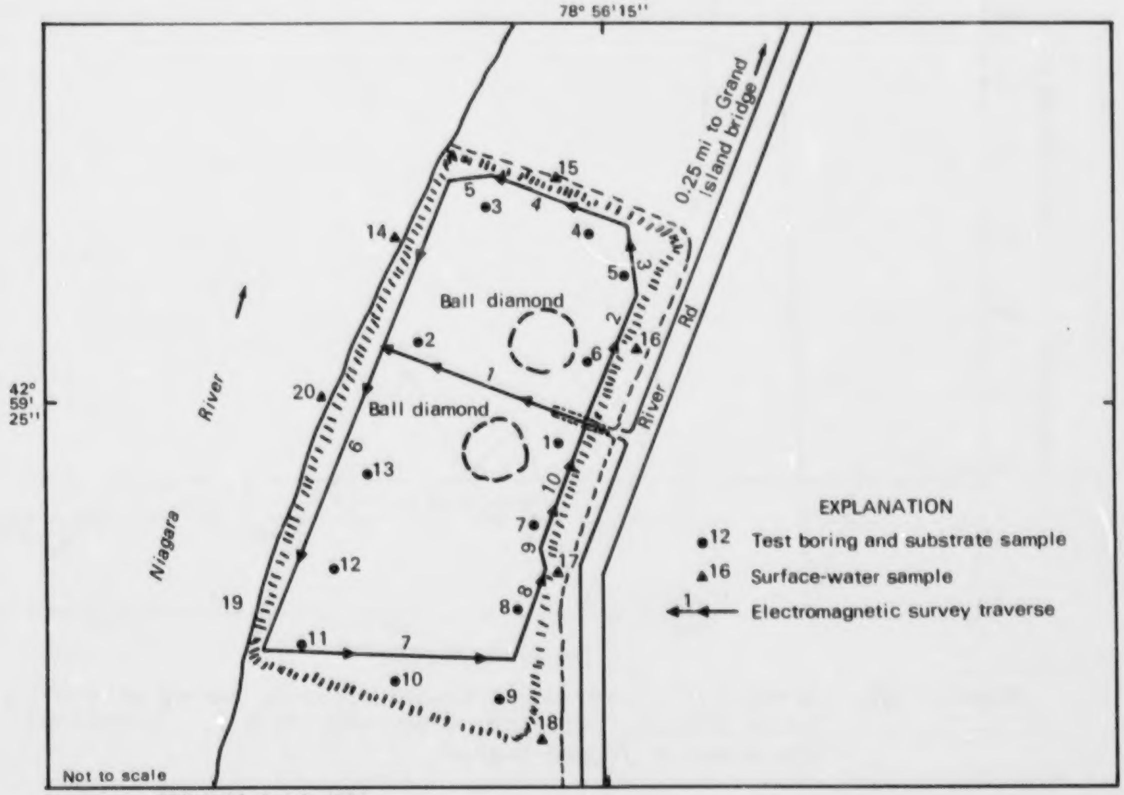
Hydrologic information.--Ground water was encountered between 11 and 16 ft below land surface within the fill material. The direction of ground-water flow is probably westward toward the Niagara River. Field inspection of the site indicates extensive surface-water runoff toward the river along the western boundary of the property.

Chemical information.--The Geological Survey collected a soil sample at each borehole in 1982 for arsenic, cadmium, chromium, iron, lead, mercury, and nickel analyses and in May 1983 for organic-compound analyses. Results are given in table B-32.

Iron and phenol exceeded USEPA criteria for drinking water. The samples contained 22 organic priority pollutants, some in concentrations as high as 199,000 µg/kg (PCB-1248), and 21 organic nonpriority pollutants, 9 possibly naturally occurring organic compounds, and some unknown hydrocarbons.

Substrate samples from sites 14, 15, 16, 19, and 20 (fig. B-28) were from drainage ditches or bottom materials from the Niagara River.

Electromagnetic survey.--The U.S. Geological Survey conducted an electromagnetic survey in November 1982 with 10 survey lines. Locations are shown in figure B-28; the data are plotted in figure B-29.



Base from USGS field sketch, 1982

Figure B-28. Locations of sampling holes, surface sample, and electromagnetic-conductivity survey lines at Huntley Power Station, site 182, Tonawanda.

With the possible exception of one reading (at the river's edge), all of lines 1 and 2 showed fluctuating readings, which indicates variable fill. Lines 3, 4, and 5 were more regular and probably indicate homogeneous fill. The sharp rise in conductivity at the end of line 5 indicats the end of the line, which is at the edge of the Niagara River and 30 ft below the rest of the line.

Line 6, along the riverbank, showed mostly background conductivity values until approximately the 2,200-ft mark, after which the values increased with numbers of what appear to be refractory bricks on the surface. The highest conductivity values were at the southern end of the line, near a large stream; this may reflect a group of small oil-containment booms strung together across the current further downstream.

Lines 7, 8, and 9 showed further evidence of varying fill material; most of the readings south of the large gulley crossed by line 8 showed both very high and very low values, whereas north of the gulley, the fluctuations were considerably smaller and departed less from the background range.

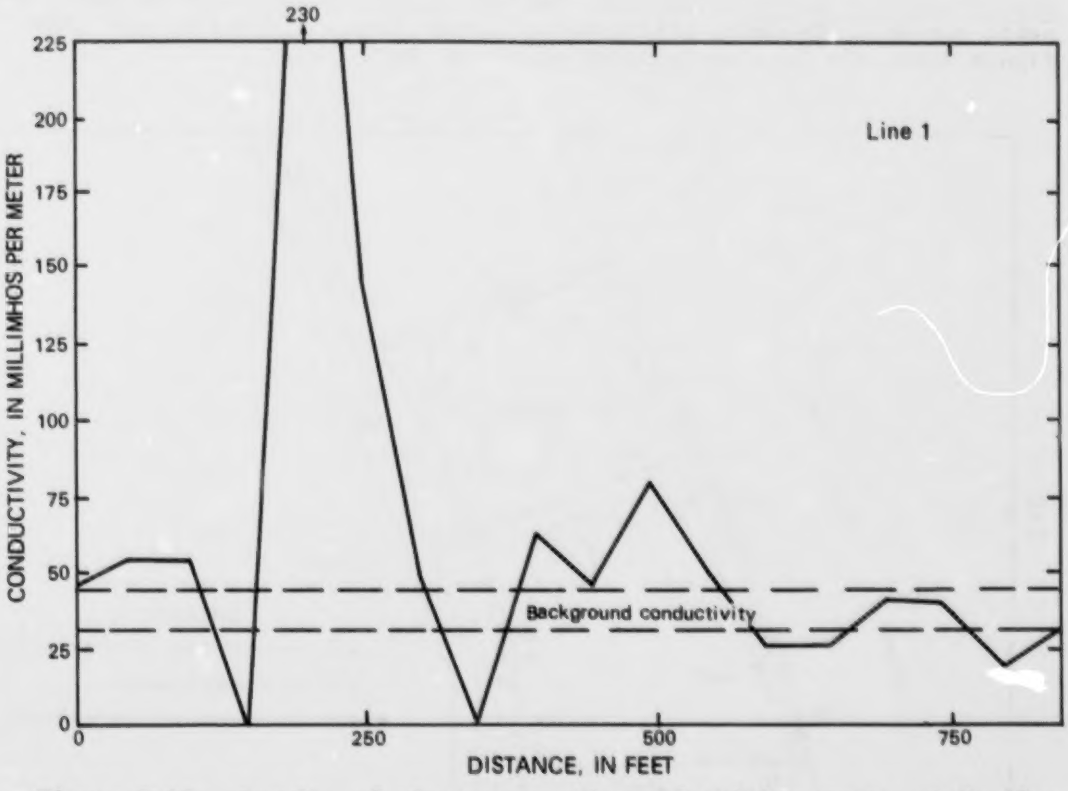


Figure B-29. Results of electromagnetic-conductivity survey at Huntley Power Station, site 182, Tonawanda, line 1. (Locations are shown in figure B-28.)

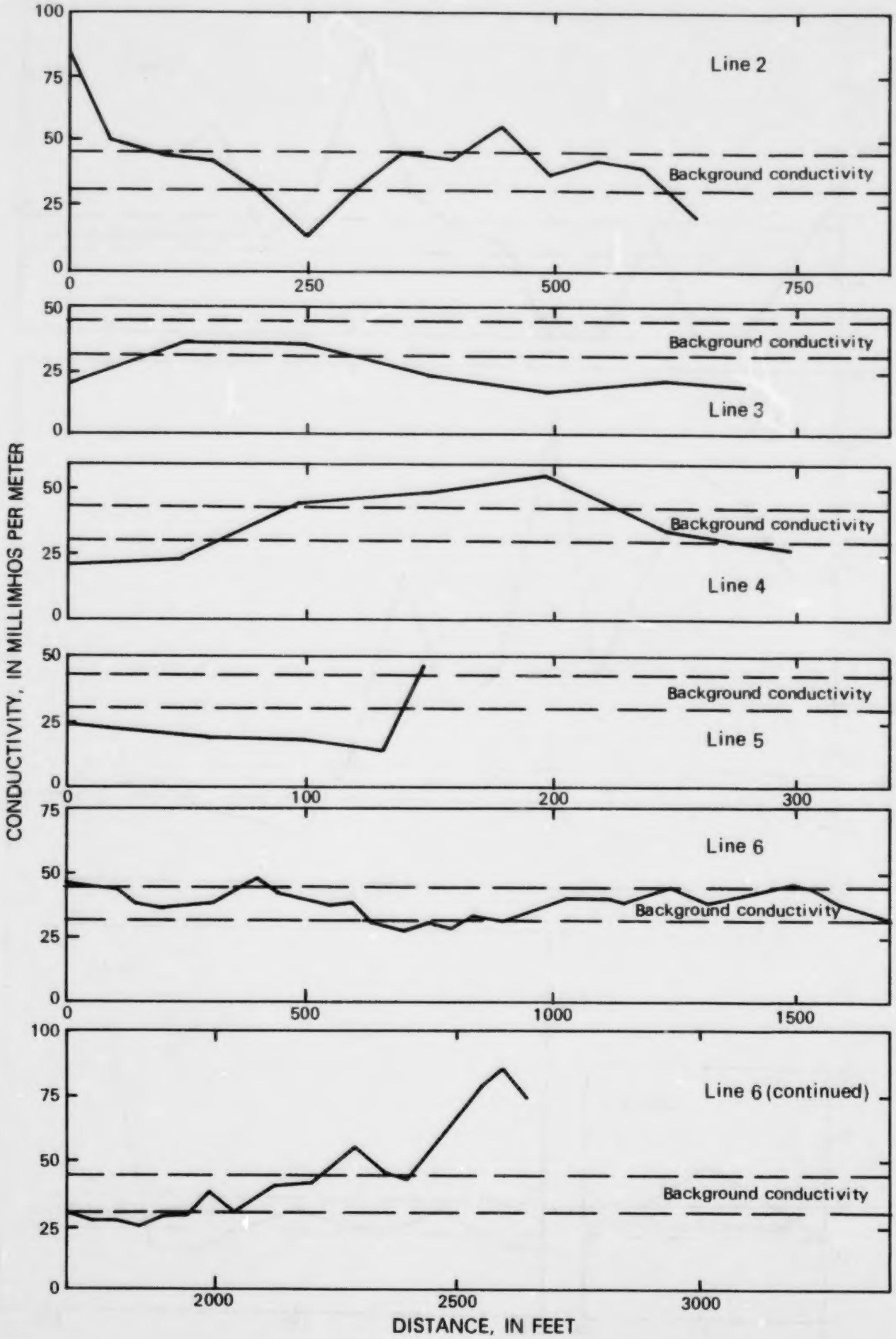


Figure B-29 (continued). Results of electromagnetic-conductivity survey at Huntley Power Station, site 182, Tonawanda, lines 2 through 6. (Locations are shown in figure B-28.)

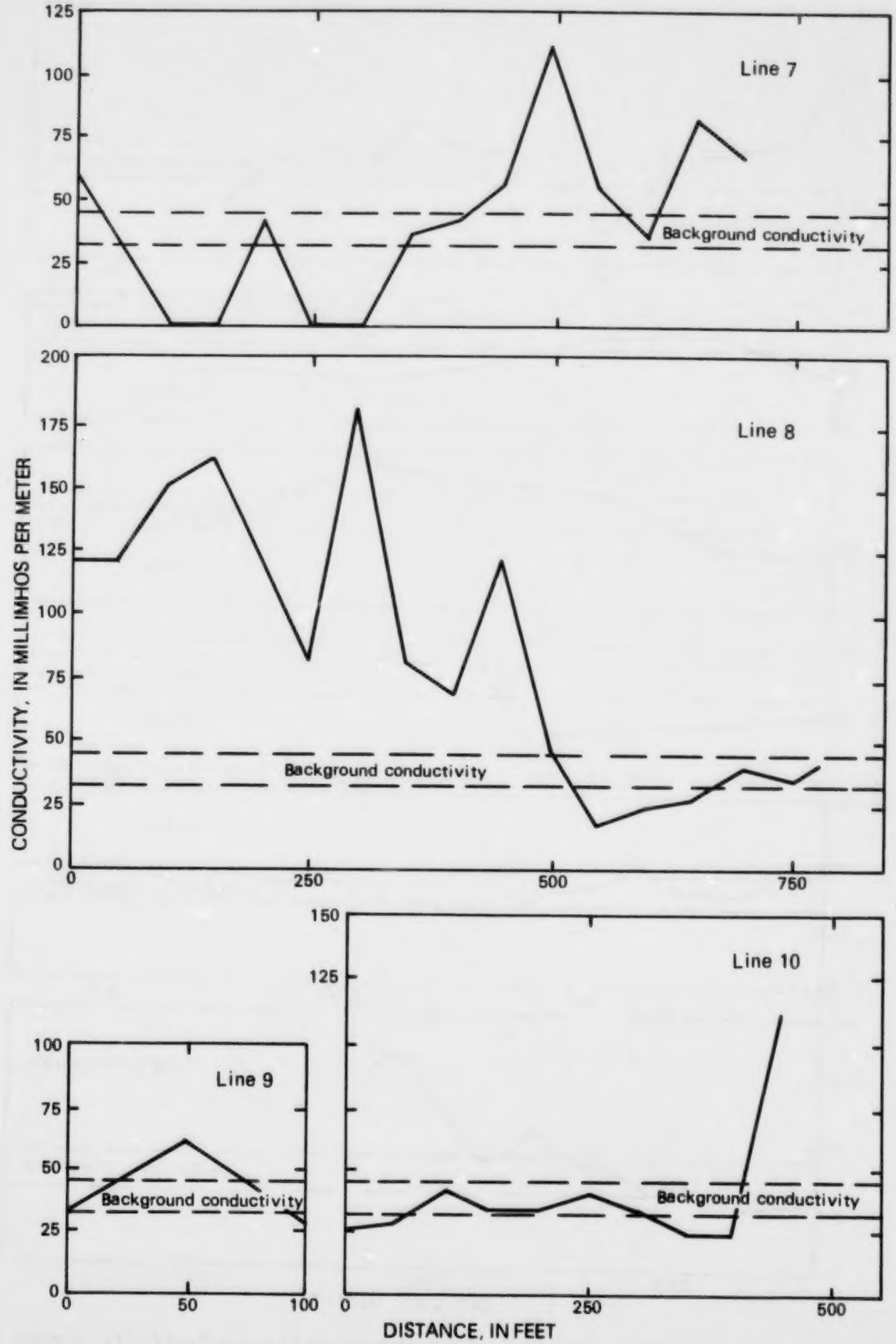


Figure B-29 (continued). Results of electromagnetic-conductivity survey at Huntley Power Station, site 182, Tonawanda, lines 7 through 10. (Locations are shown in figure B-28.)

Table B-32.--Analyses of substrate samples from Huntley Power Station, site 182, Tonawanda, N.Y.
[Locations shown in fig. B-28. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)				
First sampling (7-15-82)	1 (26.5)	2 (15.0)	3 (20.0)	4	5 (22.0)
Inorganic constituents					
Arsenic	--	--	--	--	--
Cadmium	1,000	3,000	1,000	--	--
Chromium	--	--	--	--	--
Iron	12,000,000	18,000,000	29,000,000	6,500,000	11,000,000
Lead	30,000	120,000††	30,000	20,000	10,000
Mercury	--	--	--	--	--
Nickel	10,000	--	20,000	--	--

	Sample number and depth below land surface (ft)				
First sampling (7-15-82)	6 (18.0)	7 (19.0)	8 (17.0)	9 (21.0)	10 (21.0)
Inorganic constituents					
Arsenic	--	--	--	--	--
Cadmium	1,000	--	1,000	1,000	1,000
Chromium	--	--	--	--	--
Iron	13,000,000	15,000,000	13,000,000	25,000,000	15,000,000
Lead	30,000	30,000	20,000	40,000	30,000
Mercury	--	--	--	--	--
Nickel	10,000	10,000	20,000	10,000	10,000

	Sample number and depth below land surface (ft)				
First sampling (7-16-82)	11	12 (21.0)	13 (20.0)	14	15
Inorganic constituents					
Arsenic	--	--	1,000	--	--
Cadmium	--	1,000	1,000	--	1,000
Chromium	--	--	--	--	--
Iron	--	31,000,000	12,000,000	5,900,000	8,900,000
Lead	--	40,000	30,000	20,000	20,000
Mercury	--	--	--	--	--
Nickel	--	10,000	10,000	10,000	10,000

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from undisturbed soils in the Tonawanda area.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base neutral-extractable compounds were extracted.

Table B-32.--Analyses of substrate samples from Huntley Power Station, site 182, Tonawanda, N.Y. (continued)
[Locations shown in fig. B-28. Dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

First sampling (7-16-82)	Sample number (Concentrations are in µg/kg) 16	19	20
Inorganic constituents			
Arsenic	--	--	--
Cadmium	1,000	--	--
Chromium	--	--	--
Iron	8,200,000	12,000,000	12,000,000
Lead	20,000	20,000	30,000
Mercury	--	--	--
Nickel	10,000	--	--

First sampling (7-16-82)	Surface-water sample number (Concentrations are in µg/L) 17	18
pH	7.4	7.6
Specific conductance (µmho/cm)	1,640	1,650
Temperature (°C)	26.0	28.0
Inorganic constituents		
Aluminum	2,420	280
Antimony	--	--
Arsenic	23	--
Barium	148	--
Beryllium	--	--
Cadmium	3	--
Chromium	16	13
Colbalt	--	--
Copper	--	--
Iron	4,450†	400†
Lead	7	12
Manganese	599	532
Mercury	--	--
Nickel	--	--
Selenium	--	--
Silver	--	--
Tellurium	--	--
Vanadium	--	--
Zinc	206	160

† Exceeds USEPA criterion for maximum permissible concentration in drinking water.

Table B-32.--Analyses of substrate samples from Huntley Power Station, site 182, Tonawanda, N.Y. (continued)
[Locations shown in fig. B-28. Dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)				
	1A	2A	3A	4A	5A
Second sampling (5-21-83)	(16.0)	(11.0)	(14.0)	(11.0)	(22.0)
Organic compounds					
Priority pollutants					
Benzene	18	--	--	--	--
Ethylbenzene	--	--	130	--	--
Toluene	18	--	26	12	19
PCB-1248	48,000	199,000	11,000	LT	2,500
Phenol	LT	LT	--	LT	35,000†
Fluoranthene	LT	LT	--	LT	LT
Naphthalene	LT	LT	--	LT	LT
Phenanthrene	LT	LT	--	LT	LT
Pyrene	LT	LT	--	LT	LT
2,4-Dimethylphenol	--	--	--	LT	LT
Benzo(a)pyrene	--	--	--	LT	--
Chrysene	--	--	--	LT	LT
Bis(2-ethylhexyl) phthlate	--	LT	--	--	--
Anthracene	--	LT	--	LT	--
Fluorene	--	LT	--	--	--
Nonpriority pollutants					
2-Methylnaphthalene	LT	LT	--	LT	LT
O-xylene	LT	--	510	--	--
2-Methylphenol	--	3,600	--	--	--
4-Methylphenol	--	5,700	--	--	11,000
Dibenzofuran	--	LT	--	--	--
Tetrachloro-1,1'-biphenyl[1]	--	33,000	--	--	--
2-(1-methylethyl)-phenol[1]	--	--	--	--	1,000

	Sample number and depth below land surface (ft)				
	6A	7A	8A	9A	10A
	17.0	15.0	17.0	21.0	12.0
Priority pollutants					
Methylene chloride	170	180	180	--	280
Toluene	52	24	LT	--	15
Benzene	--	--	--	--	13
PCB-1254	--	--	--	LT	--
PCB-1248	LT	LT	LT	LT	13,000
Phenol	--	LT	LT	2,200	LT
Fluoranthene	LT	LT	250	LT	--

Table B-32.--Analyses of substrate samples from Huntley Power Station, site 182, Tonawanda, N.Y. (continued)

[Locations shown in fig. B-28. Dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)				
	6A	7A	8A	9A	10A
Second sampling (5-21-83)	17.0	15.0	17.0	21.0	12.0
Organic compounds (continued)					
Priority pollutants (continued)					
Naphthalene	LT	LT	2,100	5,600	LT
Bis(2-ethylhexl)-phthalate	--	--	--	9,400	--
Diethyl phthalate	--	--	--	4,700	--
Benzo(a)anthracene	LT	--	--	LT	--
Benzo(a)pyrene	LT	--	--	--	--
Chrysene	LT	--	LT	LT	--
Fluorene	--	LT	290	LT	--
Phenanthrene	LT	LT	960	4,700	LT
Pyrene	LT	LT	LT	LT	--
2-4-Dimethylphenol	--	--	380	470	--
Nonpriority pollutants					
Carbon disulfide	--	--	--	--	16
2-Methylnaphthalene	LT	LT	2,700	5,600	LT
Acetone	120	49	120	--	--
O-xylene	23	--	--	--	--
4-Methylphenol	--	7,900	--	850	--
Dibenzofuran	--	LT	380	LT	--
Tetrachloro-1,1'-biphenyl[1]	--	44,000	--	--	--
Terphenyl[1]	3,600	--	--	--	--
1,2,3-Trimethylbenzene[1]	--	--	--	600	--
1,2-Dimethylnaphthalene[1]	--	--	--	1,450	--
2-(1-methylethyl)-phenol[1]	--	--	--	--	600
1,2-Benzenedicarboxylic acid[1]	--	--	--	--	4,000
Hexadecane[1]	3,900	--	1,750	9,000	--
Heptadecane[1]	4,400	--	1,700	--	--
Undecane[1]	--	--	1,600	5,600	--
Dodecane[1]	--	--	1,500	--	--
Tridecane[1]	--	--	1,300	18,200	--
Tetradecane[1]	--	--	1,500	6,000	--
2,6-Dimethylundecane	--	--	--	1,170	--
2,3,7-Trimethyloctane	--	--	--	1,200	--
Hexadecanoic acid	--	--	--	--	1,000

Table B-32.--Analyses of substrate samples from Huntley Power Station, site 182, Tonawanda, N.Y. (continued)

[Locations shown in fig. B-28. Dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)					
Second sampling (5-21-83)	11A (12.0)	(Split)	12A (12.0)	13A (12.0)	14A	15A
Organic compounds						
Priority pollutants						
Methylene chloride	280	(--)	180	380	880	--
Toluene	--	(--)	13	--	--	--
Trans-1,2,-dichloroethene	-	(--)	--	47	--	--
Trichloroethene	--	(--)	--	59	--	--
PCB-1254	--	(--)	--	--	--	LT
PCB-1248	18,000	(*)	20,000	21,000	1,100	750
Aldrin	--	(*)	--	--	--	--
Heptachlor epoxide	--	(*)	--	--	--	--
Phenol	--	(*)	2,900	3,400	--	--
Fluoranthene	LT	(*)	--	--	LT	--
Naphthalene	LT	(*)	LT	1,500	LT	--
2,4-Dimethylphenol	--	(*)	--	560	--	--
Bis(2-ethylexyl) phthalate	--	(*)	--	--	--	--
Benzo(a)anthracene	LT	(--)	--	--	LT	--
Benzo(a)pyrene	LT	(--)	--	--	LT	--
Acenaphthene	--	(--)	--	280	--	--
Acenaphthylene	--	(*)	--	--	--	--
Chrysene	LT	(*)	--	--	LT	--
Fluorene	--	(*)	--	280	--	--
Phenanthrene	LT	(--)	LT	560	LT	--
Pyrene	LT	(*)	--	--	LT	--
Nonpriority pollutants						
Acetone	300	(--)	220	--	--	--
Carbondisulfide	--	(--)	--	LT	--	--
2-Methylnaphthalene	LT	(*)	3,700	3,700	LT	--
4-Methylphenol	--	(*)	--	2,500	--	--
Dibenzofuran	--	(*)	--	230	--	--
1,3,5-Trimethylbenzene[1]	--	(*)	--	--	--	--
1,4-Dimethyl-2-ethylbenzene[1]	--	(*)	--	--	--	--
2-(1-methylethyl)-benzene[1]	--	(*)	--	--	--	--
7-Methyltridecane[1]	--	(*)	--	--	--	--
4-Fluoro-1,1'-biphenyl[1]	--	(*)	--	--	--	--
2-Methylundecane[1]	--	(*)	--	--	--	--

Table B-32.--Analyses of substrate samples from Huntley Power Station, site 182, Tonawanda, N.Y. (continued)
[Locations shown in fig. B-28. Dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

Second sampling (5-21-83)	Sample number					
	11A	(Split)	12A	13A	14A	15A
Organic compounds (continued)						
Nonpriority pollutants (continued)						
5-Propyl-tridecane[1]	--	(--)	3,100	--	--	--
1-Ethyl-2-methylbenzene[1]	--	(--)	--	610	--	--
1,2,3-Trimethylbenzene[1]	--	(--)	--	1,100	--	--
2-Ethyl-1,4-dimethylbenzene[1]	--	(--)	--	930	--	--
1,8-Dimethylnaphthalene[1]	--	(--)	--	1,300	--	--
1,6,7-Trimethylnaphthalene[1]	--	(*)	--	--	--	--
Unknown hydrocarbons[1]	--	(*)	--	--	--	--
Undecane[1]	--	(*)	4,900	1,100	--	--
Dodecane[1]	--	(--)	3,900	--	--	--
Tridecane[1]	--	(*)	4,400	--	--	--
Decane[1]	--	(*)	--	930	--	--
Tetradecane[1]	--	(*)	--	1,500	--	--
Hexadecane[1]	--	(--)	--	1,400	--	--
Heptadecane[1]	--	(*)	--	--	--	--
Octadecane[1]	--	(*)	--	--	--	--
2,6,10,14-Tetramethylheptadecane[1]	--	(*)	--	--	--	--

Second sampling (5-21-83)	Sample number				
	16A	17A	18A	19A	20A
Organic compounds					
Priority pollutants					
Methylene chloride	--	220	350	230	--
PCB-1248	--	390	620	320	LT
PCB-1260	--	300	590	--	--
β-BHC	10	--	--	--	--
δ-BHC	LT	--	--	--	--
Fluoranthene	--	--	--	LT	LT
Naphthalene	--	--	--	290	LT
Phenanthrene	--	--	--	LT	LT
Pyrene	--	--	--	LT	LT
Benzo(a)anthracene	--	--	--	--	LT
Benzo(a)pyrene	--	--	--	--	LT
Nonpriority pollutants					
Acetone	--	--	830	--	--
Hexane[1]	--	--	10,000	--	--

201. SEAWAY INDUSTRIAL PARK LANDFILL (Literature review) NYSDEC 915074

General information and chemical-migration potential.--The Seaway Industrial Park Landfill, in the town of Tonawanda, has been used for the disposal of fly ash, demolition debris, municipal solid waste, waste oil, spent solvents, sludges, oily sludges, dry "corian" wastes, and low-grade uranium ore tailings.

A leachate-collection system has been installed at the base of fill around the edge of the site and encloses all waste within the site. In addition, a subsurface barrier wall consisting of a clay slurry surrounds the site just outside the leachate-collection system. This wall extends into the clayey till and lacustrine clay beneath the site and thus prevents lateral migration of leachate offsite and movement of ground water into the site. Vertical migration through the clayey till and(or) lacustrine clay is unlikely. All collected leachate is piped to the Tonawanda sewer system for treatment.

Geologic information.--The site consists of recent fill and alluvium overlying a series of alternating tills and glaciolacustrine clays. Three units unconformably overlie a bedrock of Camillus Shale.

Wehran Engineering installed 5 exploratory test borings, 22 shallow exploratory test pits, and 3 monitoring wells in 1979. Results are depicted in the geologic column in figure B-30. Geologic descriptions for each of the above units are given in Recra Research Inc. and Wehran Engineering (1979).

Hydrologic information.--The hydrologic properties of each geologic unit vary locally. Permeability of the Camillus Shale reflects the extent of bedding planes and joints. The lower sandy till overlying the bedrock, which is saturated and hydraulically connected with the Camillus Shale, has a low permeability. The overlying basal glaciolacustrine unit is interbedded with sand and clay and is considered moderately permeable (Recra Research 1979). The glaciolacustrine clay unit overlying the basal unit, where present, is highly permeable. An undisturbed core had a permeability of 1.6×10^{-8} cm/s.

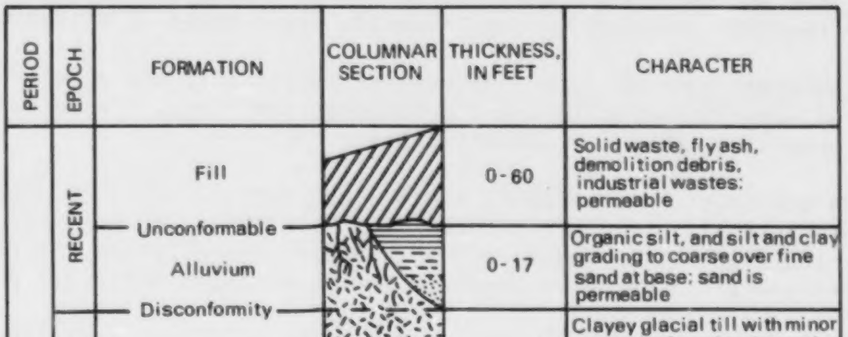
The upper clayey till, which overlies the lacustrine clay, is also highly impermeable. An undisturbed core had a permeability of 1.6×10^{-8} cm/s. The overlying recent material of fill and alluvium is the most permeable material on the site, although the alluvium contains some silt and clay.

The till and clay units are highly impermeable. Annual recharge to the site has been estimated by Recra-Wehran (1979) to be approximately 13 in/yr; an equal amount of ground-water discharge is assumed. This probably occurs as lateral movement throughout the landfill to topographic lows. The time needed for ground water to migrate through the entire thickness of impermeable material has been calculated by Recra-Wehran (1979) to be 1,500 years or 0.04 ft/yr, an estimate based on what they considered to be a conservative figure.

A map of the water-table configuration in April 1979 was drawn from water levels measured at borings and test pits. The map shows two mounds exceeding 610 ft above NGVD and separated by a depression greater than 590 ft NGVD that extends northeast-southwest across the center of the property. Ground water flows away from the mounds toward the property line, except between the mounds, where the flowlines converge to form a stream that discharges into a culvert.

Chemical information.--Recra Research, Inc. collected several surface-water samples and test-pit samples in 1979 for grouped organic-compound and heavy-metals analyses; results are published in Recra Research (1979, tables 5 through 7). The data indicate that leachate was entering the surface-water bodies bordering the property and also infiltrating into a buried drainage pipe beneath the landfill before the construction of the barrier wall. Also, PCB's were detected in two of the three piezometers on the property and in some of the surface-water samples.

Source of data.--Recra Research, Inc., and Wehran Engineering Corportion, 1979, Hydrogeologic investigation, Seaway Industrial Park Sanitary Landfill, Town of Tonawanda, New York: Buffalo, N.Y., 80 p., 1 appendix, 4 maps.



PERIOD	EPOCH	FORMATION	COLUMNAR SECTION	THICKNESS, IN FEET	CHARACTER
QUATERNARY	RECENT	Fill		0-60	Solid waste, fly ash, demolition debris, industrial wastes: permeable
		Unconformable			
		Alluvium		0-17	Organic silt, and silt and clay grading to coarse over fine sand at base; sand is permeable
		Disconformity			
	PLEISTOCENE (WISCONSIN)	Upper clayey till		0-65	Clayey glacial till with minor amounts of sand and gravel, lenticular body of laminated clay along northern perimeter: desication cracks in upper 10-12 feet, highly impermeable
		Unconformable			
		Glaciolacustrine clay unit		5-45	Laminated clay with occasional laminae of silt, soft; highly impermeable
		Conformable			
		Basal glaciolacustrine unit		0-7	Laminated clayey silt and sand, soft-loose; marginally permeable
		Unconformable			
		Lower sandy till		1-19	Sandy till, with variable amounts of silt, clay and gravel, secondary gypsum; marginally permeable
		Unconformable			
UPPER SILURIAN		Camillus shale		200± *	Gray shale; gray or brown dolomite; very thin beds of gypsum; permeable along bedding planes and vertical joints

* Upper 10 feet penetrated in drilling

Figure B-30. General geologic column of formation underlying Seaway Industrial Park Landfill, site 201, Tonawanda.

204. WILLIAM STRASSMAN PROPERTY (CONSOLIDATED FREIGHTWAYS) NYSDEC 915083
(USGS field reconnaissance)

General information and chemical-migration potential.--The William Strassman property, in the City of Tonawanda, was used as a landfill to receive foundry sand, possibly containing phenolic binders, from an automobile-manufacturing plant in Tonawanda.

Geologic data indicate limited potential for chemical migration. If migration does occur, it would be during periods of high precipitation and would be in the permeable surface material. The potential for contaminant migration is indeterminable, but the presence of contaminants and the site's proximity to the Niagara River suggest changing the potential to major.

Geologic information.--The site consists of glacial lacustrine clay and till overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled four test borings on the site in 1982; the locations are shown in figure B-31. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 8.0	Clay, red, tight, dry. SAMPLE: 4 ft.
2	0 - 5	Clay, red, tight, dry. SAMPLE: 5 ft.
3	0 - 11.5	Clay, red, damp. Hit dark green clay at about 10 ft. Green clay is about 6 in thick and is probably between fill material and natural grade. SAMPLE: 10 ft.
4	0 - 2.0	Clay, red.
	2.0 - 2.5	Clay, green, damp.
	2.5 - 6.5	Clay, red, tight, dry. SAMPLE: 2.5 ft.

Hydrologic information.--No ground water was encountered in the drilling. The regional direction of ground-water flow in the unconsolidated material is westward toward the Niagara River.

Chemical information.--The Geological Survey obtained a soil sample from each borehole for organic-compound analyses; results are given in table B-33. The samples contained 19 priority pollutants, six nonpriority pollutants, and some unknown hydrocarbons.

Table B-33.--Analyses of substrate samples from William Strassman Property, site 204, Tonawanda, N.Y., May 24, 1983.
[Locations shown in fig. B-31. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1 (2.0)	2 (2.0)	3 (2.0)	4 (2.5)
Inorganic constituent				
Molecular sulfur[1]	--	--	--	390
Organic compounds				
Priority pollutants				
Benzene	* **	*	--	--
Toluene	LT	LT	--	--
Phenol	*	--	--	--
Acenaphthene	--	--	*	--
Fluoranthene	*	* **	*	*
Naphthalene	*	--	*	--
N-nitrosodiphenylamine	--	--	*	--
Bis(2-ethylhexyl) phthalate	--	--	*	*
Di-n-octylphthalate	--	--	*	--
Benzo(a)anthracene	*	--	*	--
Benzo(a)pyrene	--	--	*	--
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	*	*	--
Chrysene	*	* **	--	--
Benzo(ghi)perylene	--	*	*	--
Phenanthrene	*	--	--	--
Fluorene	--	--	*	--
Dibenzo(a,h)anthracene	--	--	*	--
Indeno(1,2,3-cd)pyrene	--	--	*	--
Pyrene	*	* **	*	--
Nonpriority pollutants				
Dibenzofuran	*	--	*	--
2-Methylnaphthalene	*	--	*	--
Benzoic acid[1]	--	--	--	*
1-Methylpyrene[1]	--	--	*	--
Benzo(c)phenanthrene[1]	--	--	*	--
2-Octadecanol[1]	--	--	*	*
Hexadecanol[1]	--	--	--	*
Unknown hydrocarbons[1]	--	--	*	*

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified--Holding time exceeded before GC/MS acid- and base neutral-extractable compounds were extracted.

** Surrogate recoveries were outside the acceptance limits.

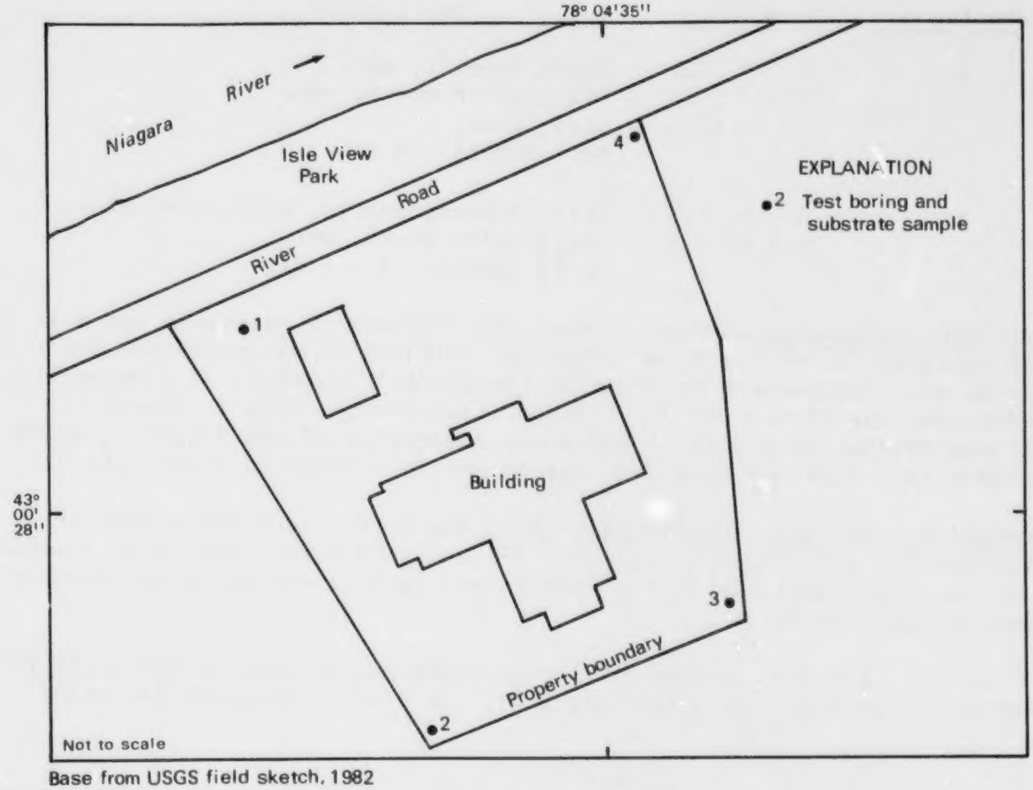


Figure B-31. Location of sampling holes at William Strassman Property, site 204, Tonawanda.

207. CITY OF TONAWANDA LANDFILL (USGS field reconnaissance) NYSDEC 915079

General information and chemical-migration potential.--The City of Tonawanda landfill, in the northern part of the City of Tonawanda, began operation in 1940 and is still active. The site has been used for disposal of industrial and municipal wastes, incinerator ash, and sewage sludge and has also accepted unknown quantities of waste from several chemical and manufacturing firms. Currently the landfill accepts only construction and demolition material and nonputrescible household waste.

Offsite migration of contaminants is indeterminable. The analyses of 10 soil and water samples from along the perimeter of the disposal area showed no significant concentrations of organic compounds; however, the leachate sampled in the wooded wetlands adjacent to the site contained high concentrations of phenol. Additional testing would be needed to confirm offsite migration.

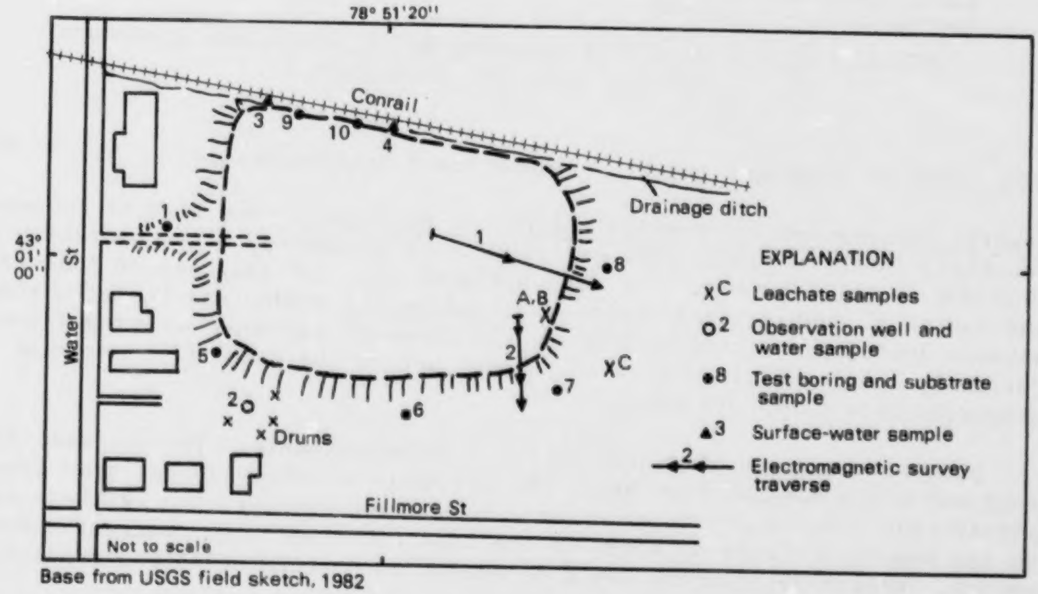
Geologic information.--The disposal area consists of fill and a thin mantle of sandy material overlying a lacustrine clay unit of Holocene age. The unconsolidated material overlies bedrock of Camillus Shale. The U.S. Geological Survey drilled two test borings on the site in 1982; locations are shown in figure B-32. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 4.0	Black topsoil, wet.
	4 - 14.0	Clay, olive green, wet.
	14 - 16.5	Clay, pink.
		SOIL SAMPLE: 5 ft.
2	0 - 6.5	Fill, blocks, debris, oily, wood bits.
	6.5 - 11.5	Clay, olive green, wet.
		WATER SAMPLE: 3 - 5 ft.

Hydrologic information.--Ground water was encountered between 4 and 6 ft below land surface. A perched water table is indicated above and within the upper clay zones. The eastern boundary of the landfill consists of a swamp that is ponded upon the clay. The direction of ground-water flow is toward the drainage ditches on the north and south boundaries of the landfill, which flow eastward to a drainage pipe that discharges into Ellicott Creek (pl. 2).

Chemical information.--In 1980 and 1981, the Erie County Department of Environmental and Planning collected and analyzed three samples of leachate from the wooded wetlands on the eastern boundary of the property; results are given in table B-34.

In 1982, the U.S. Geological Survey collected 10 samples along the perimeter of the landfill for chromium, iron, and organic compound analyses;



Base from USGS field sketch, 1982

Figure B-32. Location of monitoring wells, sampling holes, surface samples, and electromagnetic-conductivity survey lines at City of Tonawanda Landfill, site 207, Tonawanda.

results are given in table B-35. Chromium concentration in sample 8 was higher than in samples from undisturbed sites. Only one organic nonpriority pollutant and no organic priority pollutants were detected. Samples 4, 5, and 10 were not analyzed for heavy metals.

Electromagnetic survey.--The Geological Survey conducted an electromagnetic survey in November 1982 with two survey lines. Locations are shown in figure B-32; the data are plotted in figure B-33.

Both lines begin in the landfill and end beyond the limit of dumped materials, and both show elevated, erratic conductivity values within the landfill, with an immediate drop to background values beyond the edge of the landfill. No leachate plume is indicated.

Table B-34.--Analyses of leachate from City of Tonawanda Landfill, Tonawanda, site 207, N.Y., 1980-81[1]
[Locations are shown in figure B-32. Concentrations are in μg/L. Dashes indicate that constituent was not analyzed, N indicates it was detected, but in neglible quantities]

Constituent	A 12-15-80	B 4-21-81	C 4-21-81
Phenol	903	1,980	147
Cyanide	N	--	--
Pesticides	N	--	--
Herbicide 2,4-D	37.7	--	--
Total organic compounds	2,465,000	--	--
Arsenic	20	20	50
Barium	400	500	200
Cadmium	3,000	68	22
Chromium	100	300	10
Copper	180	4,270	40
Iron	91,930	44,310	5,780
Lead	3,890	450	70
Magnesium	299,500	18,500	72,200
Manganese	10,740	10,860	2,050
Mercury	0.4	0.4	0.4
Selenium	60	7	0.9
Silver	10	10	10
Zinc	15,200	5,030	720
Calcium	830,000	1,260,000	287,000
Sodium	852,000	298,700	325,700

[1] Data from Erie County Department of Environmental and Planning, 1982.

Table B-35.--Analyses of ground-water, surface-water, and substrate samples from City of Tonawanda Landfill, site 207, Tonawanda, N.Y., July-August 1982.

[Locations shown in fig. B-32. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found; blanks indicate it was not analyzed.]

	Sample number and depth below land surface (ft)				
	Substrate	Ground water	Surface water		Substrate
	1 (5.0)	2 (5.0)	3 (0.2)	4 (0.2)	5 (0.5)
pH		6.6	6.9	7.1	
Specific conductance (μmhos/cm)		1,330	940	2,340	
Temperature (°C)		16.0	23.0	25.0	
Inorganic constituents					
Chromium	--	--	3		
Iron	6,700,000	54,000†	36,000†		
Organic compounds			***	***	
Nonpriority pollutant					
Trans-4-chlorocyclohexanol[1]		54	--	--	--
1-cyclohexen-1-ol[1]		17	--	--	--
2-cyclohexen-1-one[1]		24	--	--	--

	Sample number and depth below land surface (ft)				
	Substrates				
	6 (0.5)	7 (0.5)	8 (0.5)	9 (0.5)	10 (1.0)
Inorganic constituents					
Chromium	10,000	4,000	40,000††	5,000	
Iron	47,000,000	4,100,000	15,000,000	4,400,000	
Organic compounds	--	--	--	--	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standard for maximum concentration in ground water.

†† Exceeds concentrations in samples taken from the soils of undisturbed sites in the Tonawanda area. Undisturbed soils not analyzed for iron.

***Analyzed at detection limit above that required by this study. No other compounds detected.

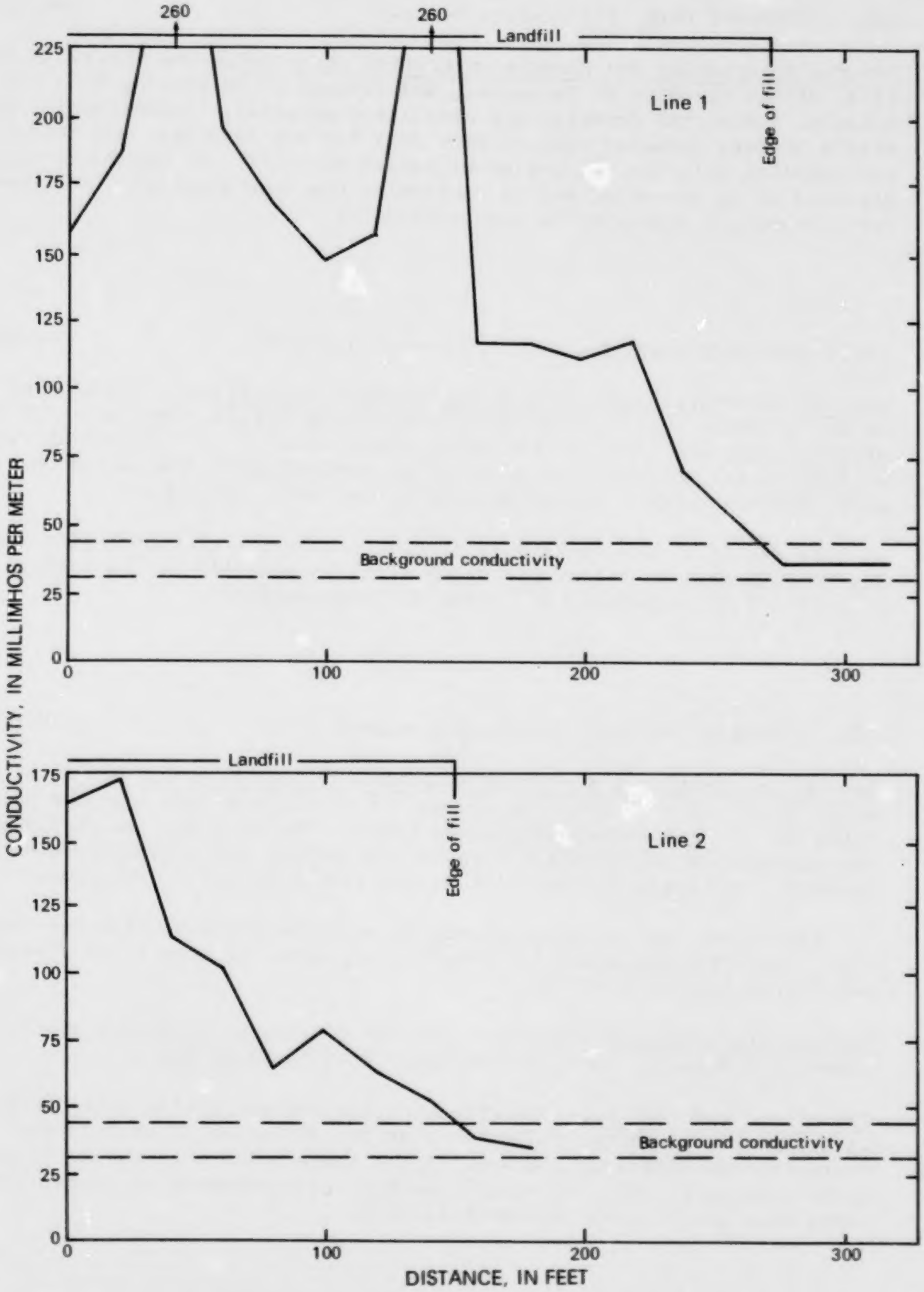


Figure B-33. Results of electromagnetic-conductivity survey at City of Tonawanda Landfill, site 207, Tonawanda, lines 1 and 2.

208. VETERAN'S PARK (Literature review) NYSDEC 915078

General information and chemical-migration potential.--The Veteran's Park site, within the City of Tonawanda, was thought to be developed on fill material containing dredging and demolition material. Investigation of the site's history revealed that offsite fill had not been used and that regrading had entailed only the relocation of native material. Nonhazardous waste was disposed of on the site, and no monitoring has been proposed. The potential for contaminant migration is indeterminable.

211. AIR FORCE PLANT NO. 40 (Literature review) NYSDEC 915067

General information and chemical-migration potential.--Air Force Plant No. 40, on the property currently owned by the General Motors Corporation in the town of Tonawanda, was used for the maintenance, repair, and testing of rocket engines during 1955-58. No evidence of generation or disposal of hazardous waste has been noted, and no monitoring has been undertaken.

The facility is underlain by glacial lacustrine clay overlying the Camillus Shale. No hydrologic or chemical information is available. The potential for contaminant migration is indeterminable.

243. BOTANICAL GARDENS (USGS reconnaissance) NYSDEC 932068

General information and chemical-migration potential.--The Botanical Gardens site, in the City of North Tonawanda, is across the road from the Holiday Park (site no. 72) and borders Tonawanda Creek. The site was reportedly used for the disposal of heavy metals, organic compounds, and plasticizers during 1958-59. The estimated quantity of material disposed is 200 tons.

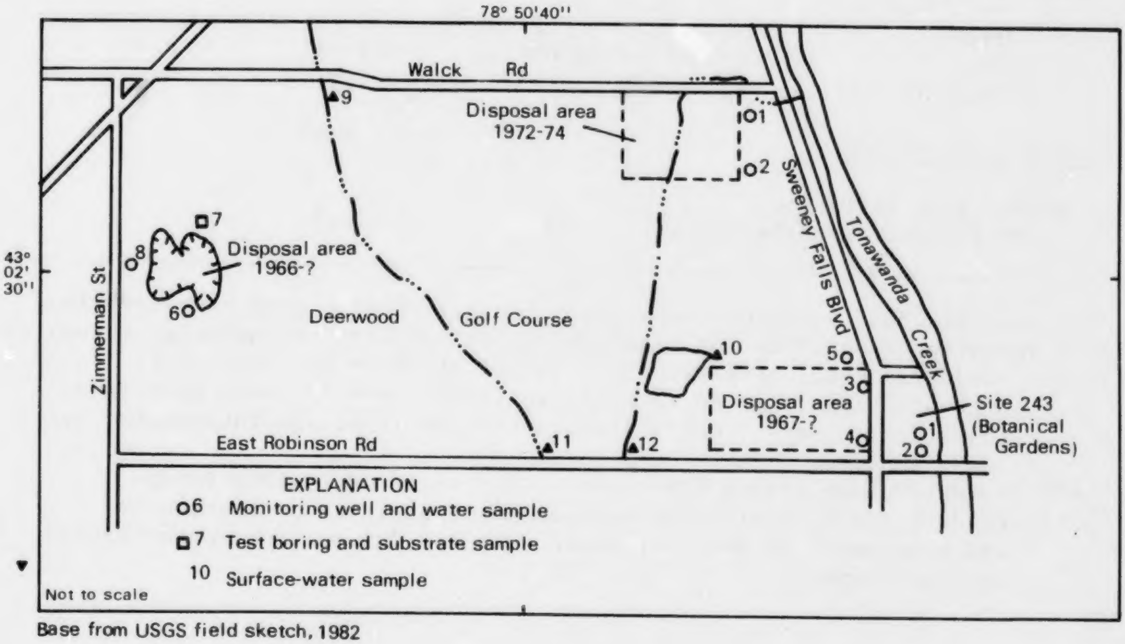
Additional data would be needed to evaluate the potential for chemical migration. The potential for chemical migration appears to be limited but is considered indeterminable.

Geologic information.--The site consists of topsoil overlying glacial lacustrine deposits underlain by bedrock of Camillus Shale.

Hydrologic information.--The site contains two monitoring wells (fig. B-34). Water-level information indicates that the direction of ground-water flow is eastward toward Tonawanda Creek. After these wells were pumped to obtain water samples in 1982, the total recovery time exceeded 48 hours, which indicates that ground-water movement is slow.

Chemical information.--In 1979, Recra Research conducted an investigation of the site. Boring logs and water-quality data are available from NYSDEC in Buffalo, N.Y.

In 1982, the U.S. Geological Survey sampled the two monitoring wells for copper, iron, and organic-compound analyses; results are given in table B-36. No organic compounds were detected except in a split sample from well 1, which contained 250 μg/L of 2-(2-butoxyethoxy) ethanol. Only iron exceeded the USEPA criterion for drinking water and the New York State standard for ground water.



Base from USGS field sketch, 1982

Figure B-34. Location of monitoring wells at Botanical Gardens, site 243, North Tonawanda.

Table B-36.--Analyses of ground-water samples from Botanical Gardens, site 243, North Tonawanda, N.Y., June 18, 1982.
[Locations shown in fig. B-34. Concentrations are in µg/L.; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit; blanks indicate it was not analyzed.]

	Sample number and depth below land surface (ft)		
	1 (20.5)	(duplicate)	2
pH	6.8		6.9
Specific conductance (µmho/cm)	1,380		1,550
Temperature (°C)	12.0		10.5
Inorganic compounds			
Copper	[1]29	(--)	[1]61
Iron	130,000†	(--)	70,000†
Molecular sulfur	LT	(LT)	
Organic compounds	***	***	
Nonpriority pollutant 2-(2-Butoxyethoxy)ethanol[2]	250	(--)	

[1] Analysis done by direct aspiration because of high iron concentration.

[2] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

*** Analyzed at detection limit above that required by this study.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

252. CREEKSIDE GOLF COURSE (USGS field reconnaissance) NYSDEC 915123

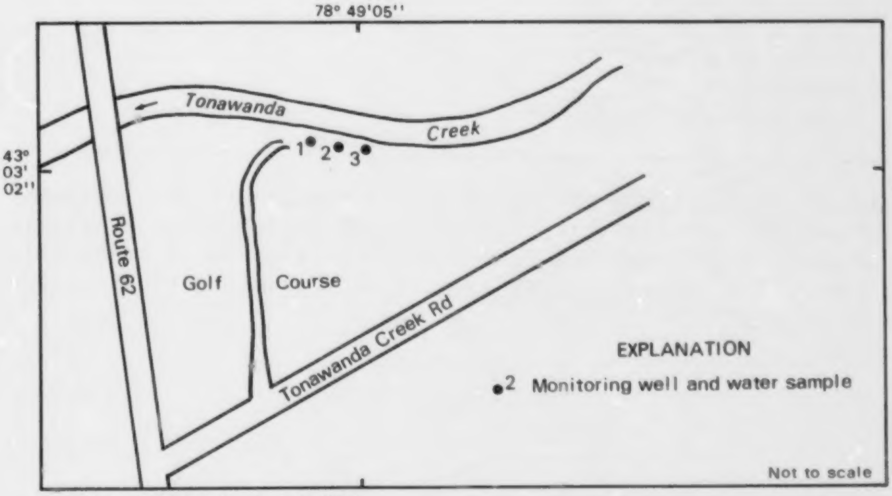
General information and contaminant-migration potential.--The Creekside Golf Course site is in the town of Amherst. Interviews by NYSDEC indicate that a few hundred barrels were disposed of during 1946-53. Most are believed to have contained phenolic tars and residues. Scrap metals from Occidental Chemical-Durez and other sources have also been disposed of at the site.

The presence of ground water suggests a possibility for contaminant migration, but the potential is indeterminable.

Geologic information.--The U.S. Geological Survey drilled three test holes on the site in 1982; locations are shown in fig. B-35. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 1.5	Brown clay and topsoil.
	1.5 - 6.5	Brown clay: compact, ropey, and moist.
	6.5 - 10.0	Fine sand, brown clay, substrate sample was fine, soupy, gray-brown clay. Well driven to 11.5 ft. SUBSTRATE SAMPLE: 9.0 ft GROUND-WATER SAMPLE: 11.5 ft
2	0 - 1.5	Brown clay and topsoil.
	1.5 - 6.5	Tight, green, ropey clay.
	6.5 - 10.0	Gray-green, soupy clay SUBSTRATE SAMPLE: 9.0 ft
3	0 - 1.5	Brown clay and topsoil.
	1.5 - 6.5	Tight, green-brown, ropey clay.
	6.5 - 10.5	Brown-gray, soupy clay. Well driven to 11.5 ft. SUBSTRATE SAMPLE: 9.0 ft GROUND-WATER: 11.5 ft

Hydrologic information.--The ground water probably flows north toward Tonawanda Creek.



Base from USGS field sketch, 1982

Figure B-35. Location of monitoring wells at Creekside Golf Course, site 252, Amherst.

Chemical information.--The U.S. Geological Survey collected two water samples and three substrate samples in 1982 for organic-compound analyses; the results are in table B-37. The only priority pollutant found was dibutyl phthalate in substrate sample 3A at a concentration of 6.9 μg/kg. One nonpriority pollutant was found.

Table B-37.--Analyses of ground-water and substrate samples from Creekside Golf Course, site 252, Amherst, N.Y., August 25, 1982.
[Locations shown in fig. B-35. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found, blank space indicates measurement not made, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)				
	Ground water	Substrates		Ground Water	Substrate
	1 (11.5)	1A (9.0)	2 (9.0)	3 (11.5)	3A (9.0)
pH	6.6			6.4	
Specific conductance (umho/cm)	715			750	
Temperature (°C)	13.0			13.0	
Organic compounds					
Priority pollutant					
Dibutyl phthalate	6.9	--	--	--	--
nonpriority pollutant					
3,4-Dimethyl-2-pentene[1]	--	--	--	--	LT

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

APPENDIX C

NIAGARA FALLS AREA SITE DESCRIPTIONS

A total of 71 waste-disposal sites in the Niagara Falls area were investigated to determine the potential for contaminant migration. Thirty-one were investigated and sampled by the U.S. Geological Survey during its 1982 test-drilling and sampling program; the remaining 40 were evaluated through a literature review.

Of the 71 sites investigated, 31 were designated as having a major potential for contaminant migration; the remaining 40 were designated as having an indeterminable potential.

The following section describes the location, past and current disposal practices, and potential for contaminant migration at the 71 sites; it also presents the geologic, hydrologic, and chemical data. Site locations are shown on plate 3.

1. AIRCO ALLOYS (Literature review) NYSDEC 932001

General information and chemical-migration potential.--The Airco Alloys site, in the city of Niagara Falls, was used for the disposal of graphite plant waste and slurried flue dusts. The site is monitored quarterly, and no significant contamination has been indicated. The waste materials were deemed nonhazardous by the New York State Department of Environmental Conservation.

Overland runoff creates a large potential for surface migration from the site.

Geologic information.--The site consists of unconsolidated deposits of clay, stratified drift, and till overlying bedrock of Lockport Dolomite. Depth to bedrock ranges from 11 to 24 ft.

Hydrologic information.--The site overlies two aquifers. The lower one is the confined aquifer of the Lockport Formation, in which water-bearing zones are generally limited to fractures in the upper zones of the Formation; the upper one is an unconfined system within the unconsolidated deposits. The direction of flow is probably southwestward.

Chemical information.--The site owner collected ground-water and surface-water samples in 1979 and 1980 for chemical analysis. The ground-water samples indicated little or no contamination, but the surface-water samples indicated an elevated chromium concentration in water leaving the site. The owners plan continued monitoring.

2. AIRCO SPEER CARBON-GRAPHITE (USGS field reconnaissance) NYSDEC 932002

General information and chemical-migration potential.--The Airco Speer Carbon-Graphite site, in the city of Wheatfield, was used during 1930-45 for the disposal of 28,800 to 144,000 yd^3 of furnace insulation, refractories, and sand as well as 2,500 gal/min of linseed oil and 7 tons of asbestos fiber and tape. Most of the area is paved to facilitate control and cleanup of process dust.

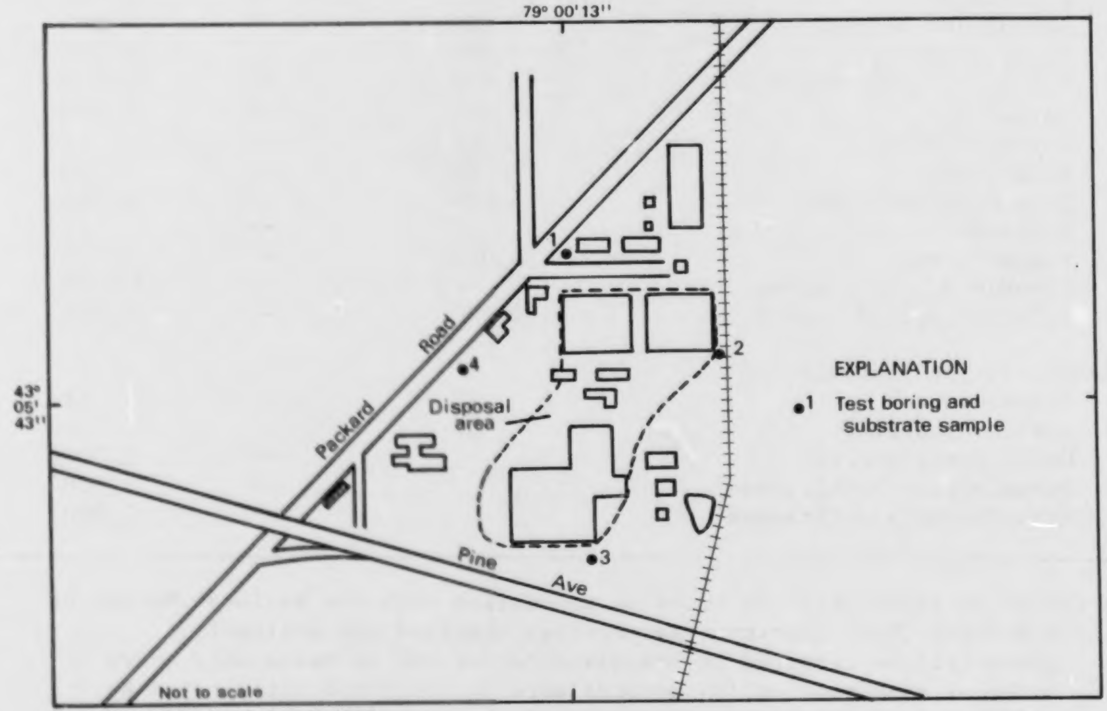
The overburden at several points on the site is only 4 to 6 ft deep, and the chemical analyses indicated high concentrations of organic priority pollutants. The potential for contaminant migration is indeterminable.

Geologic information.--The site was built on a filled area of unknown composition overlying a lacustrine silty clay. Beneath the clay is Lockport Dolomite. The U.S. Geological Survey drilled four test boring on the site in 1982; locations are shown in figure C-1. The geologic logs are on page 291.

Hydrologic information.--Ground water appears to be contained in the fractures within the bedrock and was not encountered during the 1982 drilling.

Boring no.	Depth (ft)	Description
1	0 - 2.0	Topsoil.
	2.0 - 6.2	Clay, reddish, some sand, fairly dry. Sample: 6.2 ft.
2	0 - 4.0	Topsoil, black, gravel fill. Hit bedrock at 4.0 ft. Red clay mixed in. SAMPLE: 4.0 ft.
3	0 - 2.1	Red top soil. Hit bedrock at 2.0 ft. sample: 2.0 ft.
4	0 - 1.5	Top soil, black.
	1.5 - 4.2	Clay, sandy, red, dry. Hit bedrock at 4.2 ft. SAMPLE: 4.0 ft.

Chemical information.--The U.S. Geological Survey collected four soil samples at each test boring for organic compound analyses, but the samples exceeded holding time and were recollected in May 1983. Results are given in table C-1. The samples contained 14 organic priority pollutants, some in concentrations as high as 61,000 ug/kg, and five organic nonpriority pollutants.



Base from USGS field sketch, 1982

Figure C-1. Location of sampling holes at Airco Speer Carbon-Graphite, site 2, Wheatfield.

Table C-1.--Analyses of substrate samples from Airco Speer Carbon-Graphite, site 2, Wheatfield, N.Y.
[Locations shown in fig. C-1. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
First sampling (07-14-82)	1 (6.0)	2 (4.0)	3 (2.0)	4 (4.0)
Organic compounds	***	***	***	***

	Sample number and depth below land surface (ft)		
Second sampling (05-27-83)	2A (4.0)	3A (2.0)	4A (4.0)
Inorganic compound			
Molecular sulfur	3,000	--	--
Organic compounds			
Priority pollutants			
Pyrene	8,000	LT	32,000
Acenaphthene	--	--	LT
Fluoranthene	9,100	--	34,000
Benzo(a)anthracene	7,100	--	24,000
Benzo(a)pyrene	7,900	--	49,000
3,4-Benzofluoranthene	13,000	--	43,000
Chrysene	5,600	--	23,000
Acenaphthalene	LT	--	LT
Anthracene	LT	--	2,000
Benzo(ghi)perylene	4,600	--	13,000
Fluorene	LT	--	LT
Phenanthrene	4,000	--	19,000
Dibenzo(a,h)anthracene	--	--	12,000
Indeno(1,2,3-cd)pyrene	30,000	--	61,000
Nonpriority pollutants			
Dibenzofuran	LT	--	LT
Carbon disulfide	LT	--	--
Methylphenanthrene[1]		--	2,000
Benzo(b)naphthothiophene[1]		--	2,000
Methylbenzo(a)anthracene[1]		--	2,000

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

***Analyzed at detection limit above that required by this study. No other compounds detected.

4. BASIC CARBON COMPANY (USGS field reconnaissance) NYSDEC 932004

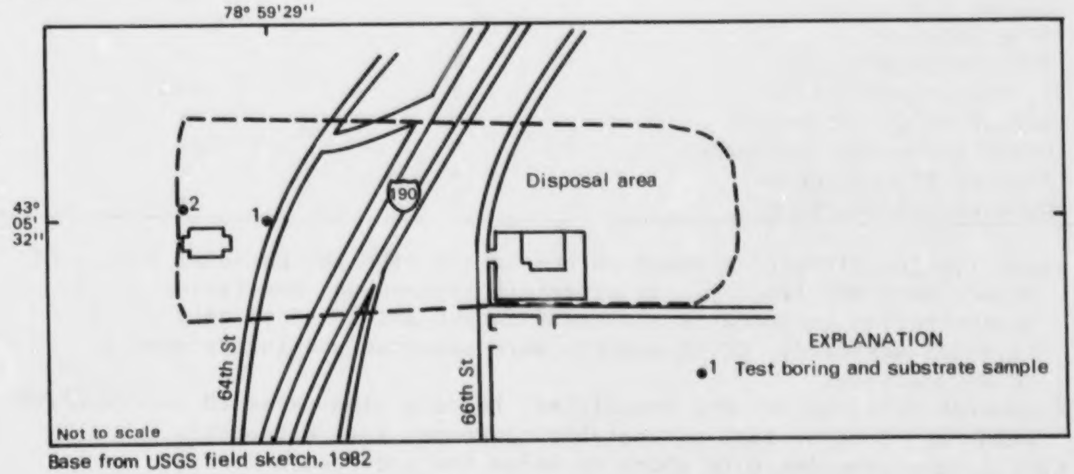
General information and chemical-migration potential.--The Basic Carbon Company, in the city of Niagara Falls, generated graphite, 30-percent coal-tar pitch, carbon, and garbage wastes in unknown quantities. Whether any of these wastes were buried on site is unknown. The site now is used as a storage area for antique automobiles and similar machinery.

The clay unit beneath the site would inhibit downward migration, and ground water, which would be the major mechanism for lateral migration, was not encountered. The U.S. Geological Survey samples may not represent conditions adjacent to the site because the exact location of the buried material was unknown. The potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled two test holes in 1982; the locations are shown in figure C-2. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 4.0	Topsoil, black with gravel at 1.0 ft.
	4.0 - 6.5	Clay, sandy, greenish black. 6 inches yellowish sand at 4 - 4.5 ft.
	6.5 -10.0	Clay, pinkish, wet at top.
		SAMPLE: 5 ft.
2	0 - 2.5	Topsoil
	2.5 - 3.5	Topsoil and fill.
	3.5 - 5.0	Sand, clayey, reddish.
	5.0 - 7.0	Clay, sandy, greenish
	7.0	Clay, pink.
		SAMPLE: 6 ft.

Hydrologic information.--No ground water was encountered during the test drilling and may be restricted to fractures in the underlying bedrock. Additional drilling would be needed to define the hydrologic characteristics beneath the site.



Base from USGS field sketch, 1982

Figure C-2. Location of sampling holes at Basic Carbon Company, site 4, Niagara Falls.

Chemical information.--The U.S. Geological Survey collected two soil samples for organic-compound analyses; results are given in table C-2. The samples contained 13 organic priority pollutants, most at concentrations below the quantifiable detection limit, and seven organic nonpriority pollutants and some unknown hydrocarbons.

Table C-2.--Analyses of substrate samples from Basic Carbon, site 4, Niagara Falls, N.Y., May 26, 1983.
[Locations shown in fig. C-2. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)	
	1 (4.0)	2 (4.5)
Organic constituents		
Priority polluants		
Acenaphthene	*	*
Hexachlorobenzene	*	--
Fluoranthene	*	* **
Naphthalene	*	*
Bis(2-ethylhexyl) phthalate	*	--
Benzo(a)anthracene	*	* **
Benzo(a)pyrene	*	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	*
Acenaphthylene	*	*
Benzo(ghi)perylene	*	*
Fluorene	*	--
Indeno(1,2,3-cd)pyrene	*	* **
Pyrene	52.0	* **
Nonpriority pollutants		
Carbon disulfide	--	*
Dibenzofuran	*	*
2-Methylnaphthalene	*	*
1,2-Benzoisothiazole[1]	*	--
4-Fluoro-1,1'-biphenyl[1]	*	--
O-aniliophenylthiocyanate[1]	*	--
Benzo(j)fluoranthene[1]	*	*
Unknown hydrocarbons	*	*

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

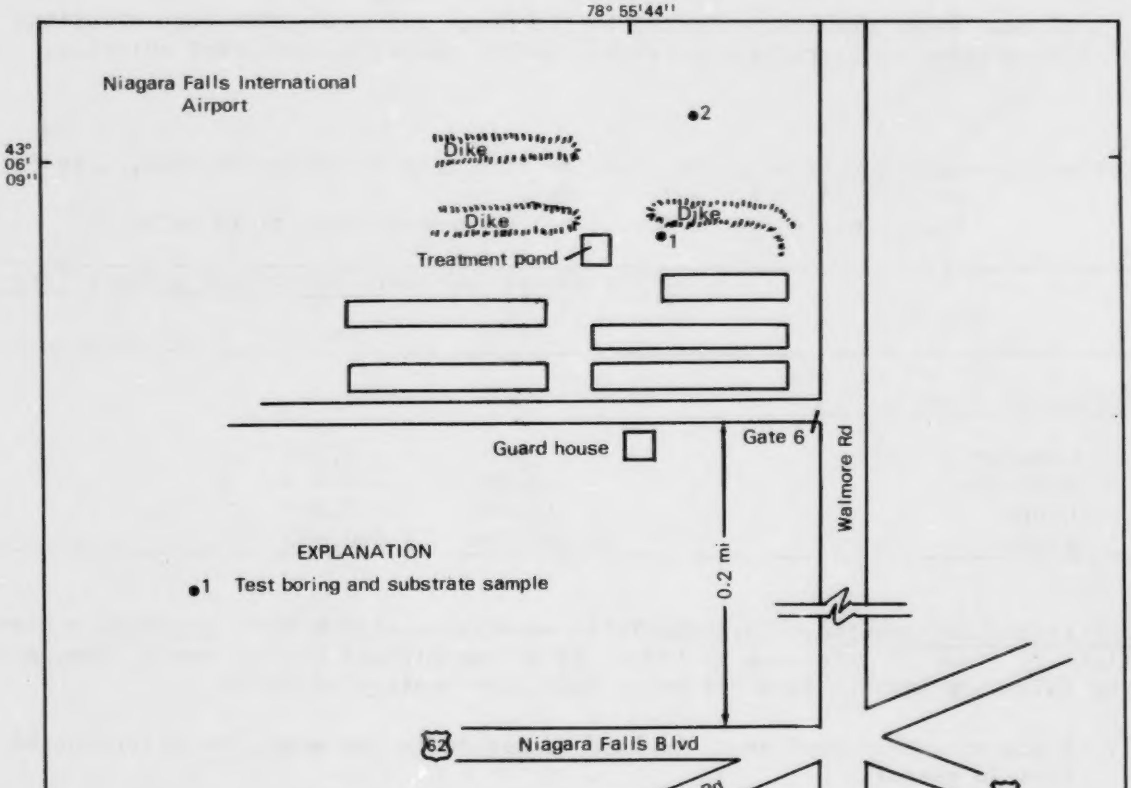
** Surrogate recoveries were above or below the acceptance limits.

5. BELL AEROSPACE TEXTRON (USGS field reconnaissance) NYSDEC 932052

General information and chemical-migration potential.--The Bell Aerospace Textron site, in the town of Wheatfield, consists of a 60-ft by 50-ft neutralization pond that has been used since the 1950's. Wastes are held in the pond until they reach a pH of 6 to 9 and are then discharged into a sanitary sewer. The wastes generally consist of rocket fuels, nitric acid, sodium hydroxide neutralizer, and plating wastes.

The site has a major potential for contaminant migration. The chemical data show elevated concentrations of chromium and copper in soil away from the pond. Results of an investigation by the property owners indicate that leachate from the pond is migrating into the ground water. Additional data would be needed to describe the geohydrology of the site.

Geologic information.--The U.S. Geological Survey drilled two boreholes on the site in 1982; the locations are shown in figure C-3. The geologic logs are on page 296.



Base from USGS field sketch, 1982

Figure C-3. Location of monitoring wells at Bell Aerospace Textron, site 5, Wheatfield.

Boring no.	Depth (ft)	Description
1	0 - 3	Topsoil.
	3 - 9	Clay, red, hit hard zone at 9 ft.
		SOIL SAMPLE: 5 ft.
2	0 - 1.5	Topsoil, black to gray.
	1.5 - 4.0	Same as above, slag.
	4.0 - 8.0	Clay.
	8.0 - 9.0	Clay, pink.
		SOIL SAMPLE: 5 ft.

Hydrologic information.--No ground water was encountered during the test drilling and is probably restricted to the lower unconsolidated units and fractures in the dolomitic bedrock underlying the site.

Chemical information.--The U.S. Geological Survey collected a soil sample at each test hole for cadmium, chromium, copper, and iron analyses; results are given in table C-3. None of the heavy-metal concentrations exceeded those samples of undisturbed soils in the area.

Ground water samples collected by the owner contained high concentrations of dichloroethylene, trichloroethylene, methyl chloride, and vinyl chloride.

Table C-3.--Analyses of substrate samples from Bell Aerospace Textron, site 5, Wheatfield, N.Y., July 1, 1982.
[Locations shown in fig. C-3. Concentrations are in µg/kg.]

	Sample number and depth below land surface (ft)	
	1 (6.5)	2 (5.0)
Inorganic constituents		
Cadmium	1,000	1,000
Chromium	10,000	4,000
Copper	14,000	7,000
Iron	15,000,000	1,700,000

Additional information.--Goldberg-Zoino Associates of New York City made a preliminary study of this site in 1982. In an unpublished status report, they give the following results from six newly installed monitoring wells.

1. A ground-water mound seems to have formed below the pond; the direction of flow is radial.

2. Estimated ground-water flow rate is 15 ft/yr.

3. Leachate from the pond has migrated to the water table and is moving radially from the pond.

The report also recommends the installation of additional monitoring wells and continued sampling to help define the geohydrology of the site for use in planning remedial action.

As part of an investigation by the site owner, several wells were drilled on the site. Two water samples were collected at a downgradient well and were analyzed for volatile organic compounds. Results are as follows:

Priority pollutants	Mean concentration of two samples (in µg/L)
Methylene chloride	125,000
Trichlorofluoromethane	15,000
1,1-Dichloroethylene	375
1,1-Dichloroethane	140
Trans-1,2-dichloroethylene	14,000
Chloroform	910
1,2-Dichloroethane	15
1,1,1-Trichloroethane	630
Trans-1,3-dichloropropylene	27
Trichloroethylene	420,000
Benzene	66
Tetrachloroethylene	38
Toluene	65
Ethyl benzene	26
Vinyl chloride	665

Source of data.--Goldberg-Zoino Associates, 1982, Unpublished status report about Bell Aerospace Textron site: New York, Goldberg-Zoino Associates.

7. CARBORUNDUM, BUILDING 89 (Literature review) NYSDEC 932048a

General information and chemical migration potential.--The Carborundum Building 89 site, along Buffalo Avenue in the city of Niagara Falls, was used during 1972-78 to dispose of coolant containing 50 parts water to 1 part alkaline concentrate with citride amine, as well as steel chips and abrasive sludge. The quantity of waste deposited was 5,200 gal/yr. The site has been remediated by excavation of the surface soils.

The potential for contaminant migration is indeterminable. Additional sampling of soil and ground water would be needed to evaluate the effect of the disposal practices on the underlying ground water.

Geologic information.--No site-specific information is available. The site probably consists of fill and glacial material overlying bedrock of Lockport Dolomite.

Hydrologic information.--No site-specific information is available. Ground-water flow in the unconsolidated deposits is probably southward toward the Niagara River; flow in the bedrock is probably westward toward the gorge.

Chemical information.--The site owners collected four soil samples for nitrate, nitrite, and iron analyses. Data are available from the property owners.

8. CARBORUNDUM, BUILDING 82 (Literature review) NYSDEC 932048-b

General information and chemical-migration potential.--Building 82 is at Carborundum's Buffalo Avenue Plant in Niagara Falls. The area south of Building 82 is used as a transfer point for general waste products, which include silicon dust and fibers. The waste is sent away for disposal. No geologic, hydrologic, or chemical information is available. The potential for contaminant migration is indeterminable.

9. CARBORUNDUM--ABRASIVE DIVISION (Literature review) NYSDEC 932007

General information and chemical-migration potential.--The Carborundum-Abrasive Division site, in the town of Wheatfield, was an open dump used during 1968-76 to dispose of 800 to 1,600 pounds of phenols and 400 tons of solidified resins, floor sweepings, and waste fillers, including calcium carbonate, clays, and animal glue. This site has been remediated through the installation of a clay cap, which was joined to the silty clay around the site. The potential for contaminant migration is indeterminable.

Geologic information.--The site consists of clay and silty fill underlain by a silty lacustrine clay, which is in turn underlain by a discontinuous layer of till. These units overlie bedrock of Lockport Dolomite. A geologic cross section is shown in figure C-4.

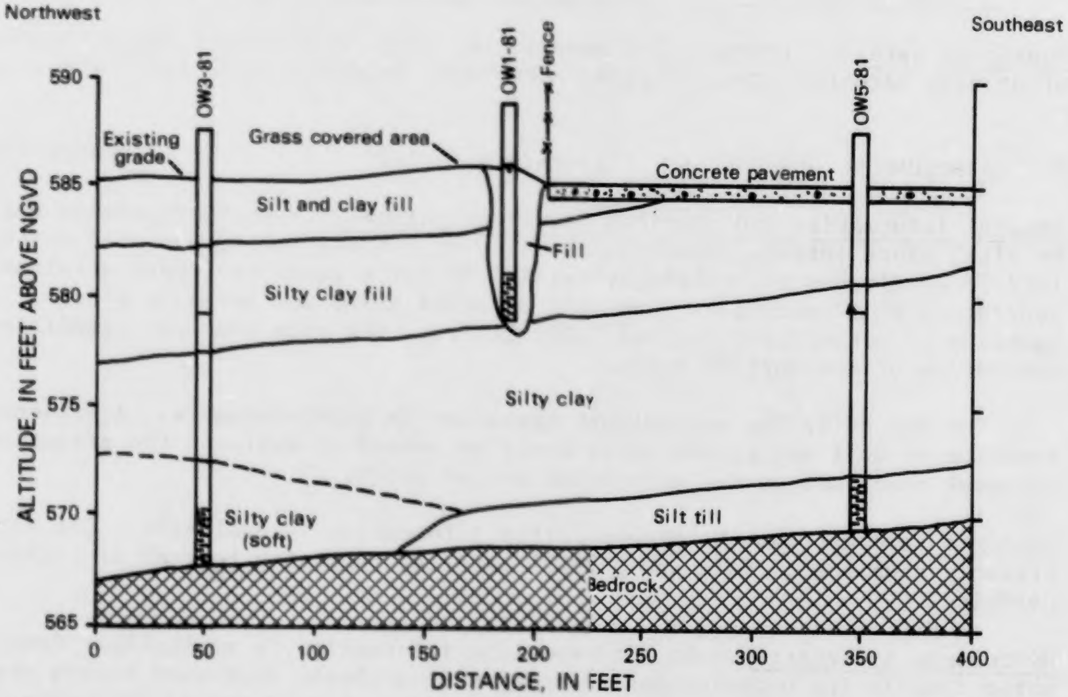
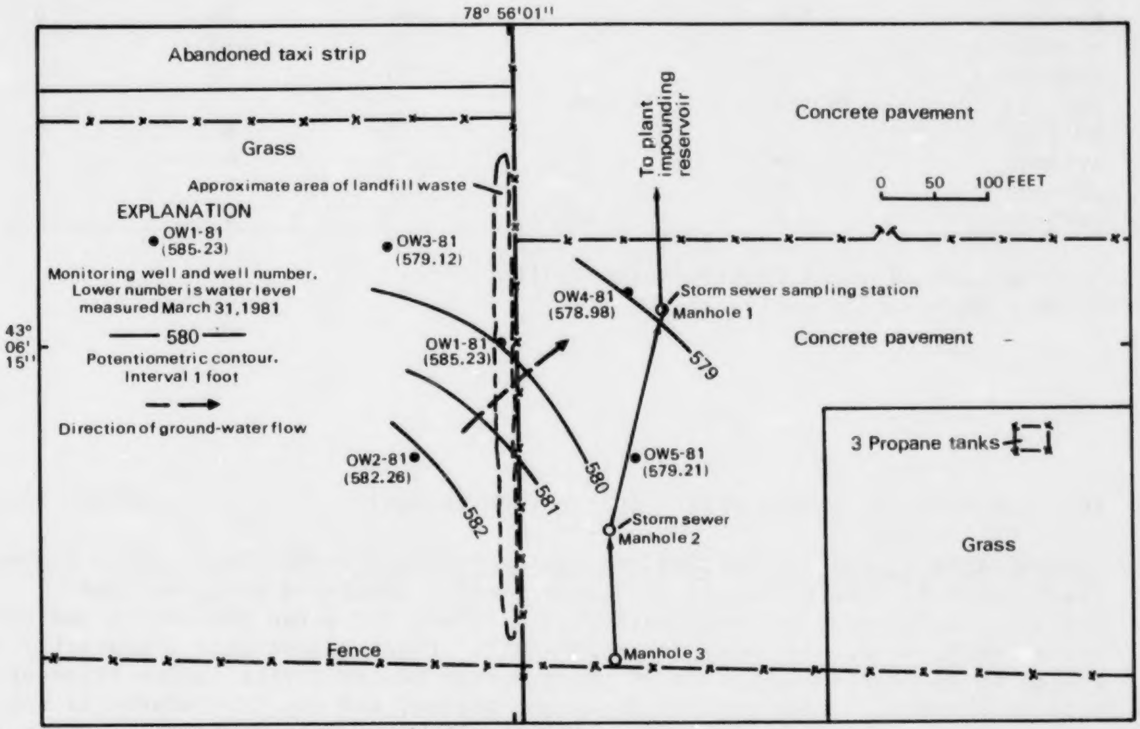


Figure C-4. Geologic cross section of formations underlying Carborundum-Abrasive Division, site 9, Wheatfield. (Modified from Conestoga-Rovers and Assoc., 1981.)

Hydrologic information.--The property owners installed five monitoring wells on the site; locations are shown in figure C-5. Water-level measurements taken in 1981 indicate ground-water flow to be northeastward. The potentiometric contours and direction of ground-water flow are given in fig. C-5.



Base and data from Conestoga-Rovers and Associates, 1981

Figure C-5. Potentiometric surface at the overburden-bedrock interface and location of monitoring wells at Carborundum-Abrasive Division, site 9, Wheatfield.

Chemical information.--Advanced Environmental Systems collected eight groundwater samples from each of the five monitoring wells and three manholes five times from February through November 1981 for phenol analysis; results are shown in table C-4.

Source of data.--Conestoga-Rovers and Associates, 1981, Hydrogeologic investigation, Landfill site, Carborundum: Toronto City, 25 p., 1 append.

Table C-4.--Phenol concentrations in ground-water samples from Carborundum Abrasive Division, site 9, Wheatfield, N.Y., 1981. [Concentrations in μg/L, <1 = detection limit. Blank space indicates no analysis performed.)[1]

Sample[2]	Date of collection				
	2-17-81	3-4-81	9-15-81	10-6-81	11-24-81
Field Blank	<1	<1	<1	2	3
Manhole 1	250	1	<1	14	6
Manhole 2			<1	13	<1
Manhole 3			<1	30	<1
OW-1-81	53,500	50,000			
OW-2-81	11	7	<1	8	1
OW-3-81	9	8	4	6	4
OW-4-81	17	<1	<1	4	2
OW-5-81	25	24	4	5	<1

[1] Data from Advanced Environmental Systems, Inc.

[2] OW = Observation wells.

10. CARBORUNDUM, GLOBAR PLANT (Literature review) NYSDEC 932036

General information and chemical-migration potential.--The Carborundum Globar Plant, on Hyde Park Boulevard in Niagara Falls, generated sand, fly ash, pallets, incinerator ash and residue until 1962, and scrap containers and products, wood, pulp, and empty drums as waste. Plant wastes were temporarily stored in the northeast corner of the property before onsite incineration or offsite disposal. This site is no longer active, and the incinerator is not used. No geologic, hydrologic or chemical information is available. The potential for chemical migration is indeterminable.

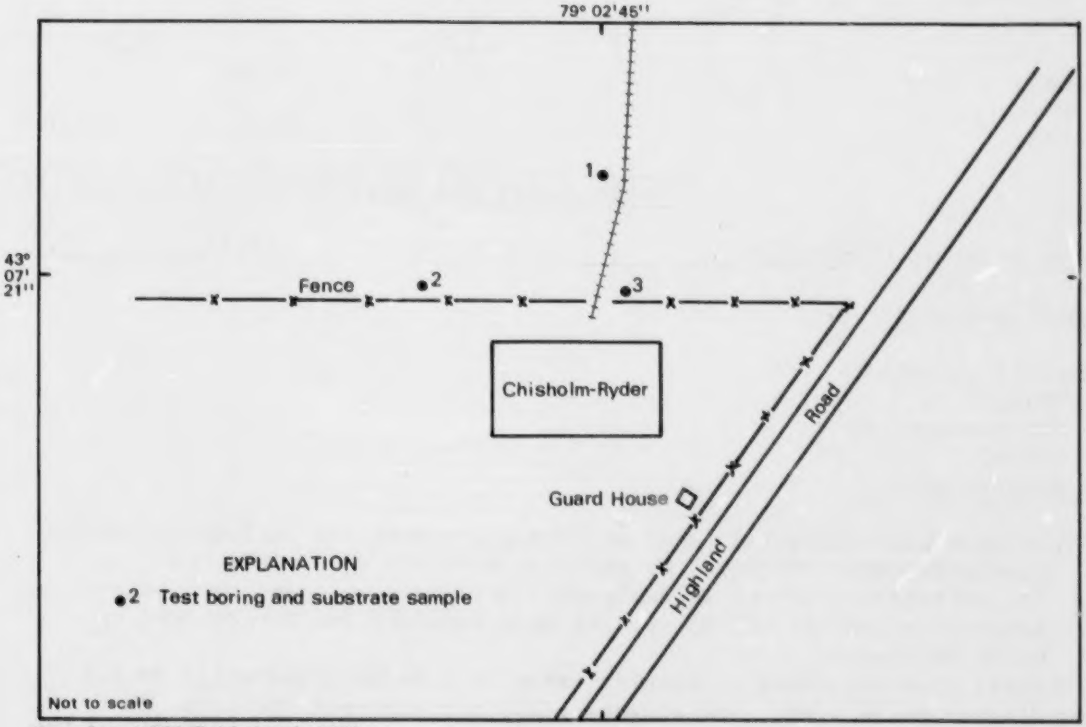
11. CHISHOLM RYDER (USGS field reconnaissance) NYSDEC 932009

General information and chemical-migration potential.--The Chisholm Ryder site, in the city of Niagara Falls, was used to dispose of unknown quantities of ash, cinders, rubble, grease, oil, metal turnings, and water-soluble coolant.

The potential for vertical contaminant migration may be high because the overburden is shallow. The elevated concentrations of some heavy metals such as zinc and the presence of organic priority pollutants indicate that sampling may have been within the burial area. The potential for contaminant migration is indeterminable because the hydrogeologic data are limited.

Geologic information.--The site consists of fill overlying a veneer of ground-moraine material that overlies bedrock of Lockport Dolomite. The U.S. Geological Survey drilled three test holes on the site in 1982; the locations are shown in figure C-6. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 1.5	Black organic soil.
	1.5 - 2.0	Same, impenetrable materials, possibly bedrock at 2 ft.
		SAMPLE: 2 ft.
2	0 - 3.5	Reddish brown topsoil.
	3.5 - 5.0	Silt (?), tan, friable, some gravel, dry, sandy.
	5.0 - 6.5	Silt or clay, reddish, dry, some gravel.
	6.5 - 8.5	Same, impenetrable material, possibly bedrock at 8.5 ft.
		SAMPLE: 8.5 ft.
3	0 - 1.0	Black organic topsoil.
	1.0 - 5.0	Clay, sandy, reddish, gravelly.
		SAMPLE: 5 ft.



Base from USGS field sketch, 1982

Figure C-6. Location of sampling holes at Chisholm Ryder, site 11, Niagara Falls.

Hydrologic information.--Ground water was not encountered and is probably confined to fractures in the underlying bedrock.

Chemical information.--The U.S. Geological Survey collected three soil samples for cadmium, chromium, copper, iron, lead, mercury, zinc, and organic-compound analyses; results are shown in table C-5. The concentrations of zinc in samples 2 and 3 are substantially higher than in samples collected in undisturbed soils not affected by hazardous-waste-disposal practices. The samples contained 14 organic priority pollutants, 15 organic nonpriority pollutants, and some unknown hydrocarbons.

Table C-5.--Analyses of substrate samples from Chisholm Ryder, site 11, Niagara Falls, N.Y.
[Locations shown in fig. C-6. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
First sampling (06-30-82)	1 (2.0)	2 (8.5)	3 (5.0)
Inorganic constituents			
Cadmium	1,000	2,000	2,000
Chromium	10,000	2,000	3,000
Copper	5,000	3,000	12,000
Iron	13,000	26,000	1,500,000
Lead	10,000	20,000	50
Mercury	--	--	--
Zinc	2,000	200,000†	220,000†

	Sample number and depth below land surface (ft)		
Second sampling (05-25-83)	1A (2.0)	2A (8.5)	3A (5.0)
Organic compounds			
Priority pollutants			
Toluene	--	--	3.3**
Trichloroethene	--	--	4.8**
Phenol	--	--	*
Fluoranthene	*	*	*

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds concentrations in samples taken from undisturbed soils in the Niagara Falls area. Undisturbed soils not analyzed for iron.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

** Surrogate recoveries were outside the acceptance limits.

Table C-5.--Analyses of substrate samples from Chisholm Ryder, site 11, Niagara Falls, N.Y. (continued)
[Locations shown in fig. C-6. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
Second sampling (05-25-83)	1A (2.0)	2A (8.5)	3A (5.0)
Organic compounds (continued)			
Priority pollutants (continued)			
Naphthalene	*	--	*
Di-n-butyl phthalate	*	--	*
Bis(2-ethylhexyl) phthalate	*	--	--
Benzo(a)pyrene	--	--	*
Benzo(a)anthracene	--	*	--
Benzo(b)fluoranthene and benzo(k)fluoranthene	*	*	*
Acenaphthylene	--	--	*
Benzo(ghi)perylene	--	--	*
Indeno(1,2,3-cd)pyrene	--	--	*
Pyrene	--	*	*
Nonpriority pollutants			
Carbon disulfide	--	--	43.7**
O-xylene	--	--	9.6**
Benzoic acid	--	--	*
Dibenzofuran	--	--	*
2-methylnaphthalene	*	--	*
Trans-2-chloro-cyclohexanol[1]	*	--	
Dibutyl-dodecanedioate[1]	*	--	
Di-isooctyl phthalate[1]	*	--	
Trichlorofluoromethane[1]	--	--	*
Tetrahydrofuran[1]	--	--	*
Cyclohexane[1]	--	--	*
Methylcyclohexane[1]	--	--	*
1,1,3-Trimethylcyclopentane[1]	--	--	*
Cis-1,2-Dimethylcyclohexane[1]	--	--	*
1,1,3-Trimethylcyclohexane[1]	--	--	*
(1-Methylethyl)-cyclohexane[1]	--	--	*
1,3- and 1,4-Dimethylbenzene[1]	--	--	*
Unknown hydrocarbons[1]	*	--	*

14. DUPONT, NECCO PARK (Literature Review) NYSDEC 932047

General information and chemical-migration potential.--The Necco Park landfill, a 25-acre site in the city of Niagara Falls, was used during 1930-77 for the disposal of 93,000 tons of sodium cell brick, graphite scrap and butts, sludge from brine-plant salt dissolver, furnace brick and rubble, scrap Elvanol, chlorinolysis residues, and other chemicals. The site has since been clay capped, and the owner installed three wells on the south side of the site to collect leachate that was infiltrating into the bedrock aquifer.

The potential for contaminant migration is major. The chemical data collected at the site and adjacent areas indicates a leachate plume migrating south-southeast from the landfill. The plume also has migrated into the upper 20 ft of the Lockport Dolomite, where it has been estimated to be moving laterally at the rate of 100 ft/yr. No migration of contaminants to surface-water bodies or sewerlines is evident.

Geologic information.--The site consists of fill overlying a sequence of clays that are underlain by Lockport Dolomite. The unconsolidated deposits range in thickness from 0 to 20 ft. A generalized east-west cross section of the site is shown in fig. C-7.

Hydrologic information.--The site owner installed several monitoring wells along the periphery of the site and measured water levels in both overburden and bedrock wells. The potentiometric surface of each unit in March 1981 are shown in figure C-8.

Advanced Environmental Systems, Inc. (written commun., 1982) ran aquifer tests at some of the monitoring wells. The transmissivity of the bedrock aquifer is highly variable because of anistropy due to fractures. Transmissivity values ranged from 195 (gal/d)/ft^2 to as high as 8,399 (gal/d)/ft^2 (Weston, 1979).

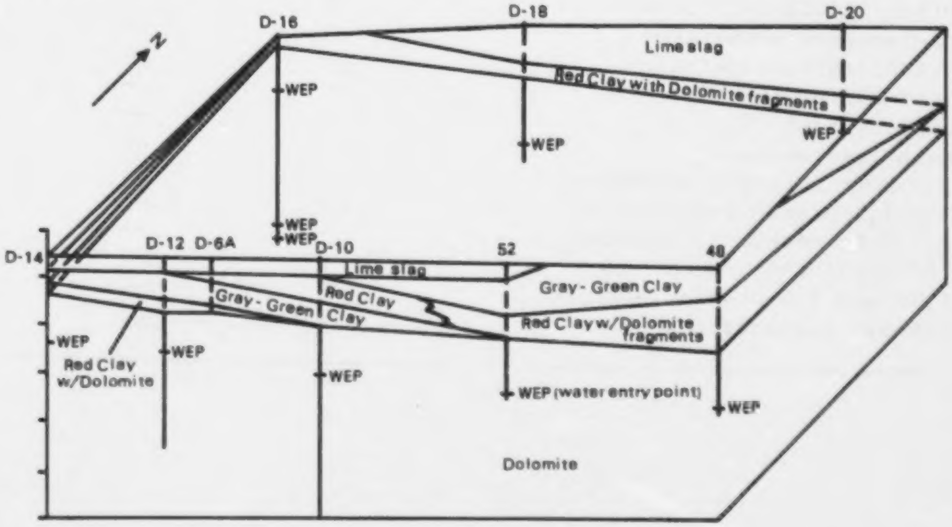


Figure C-7. General geologic cross section of formations underlying Dupont, Necco Park, site 14, Niagara Falls. (Modified from Wehran, Inc., 1981.)

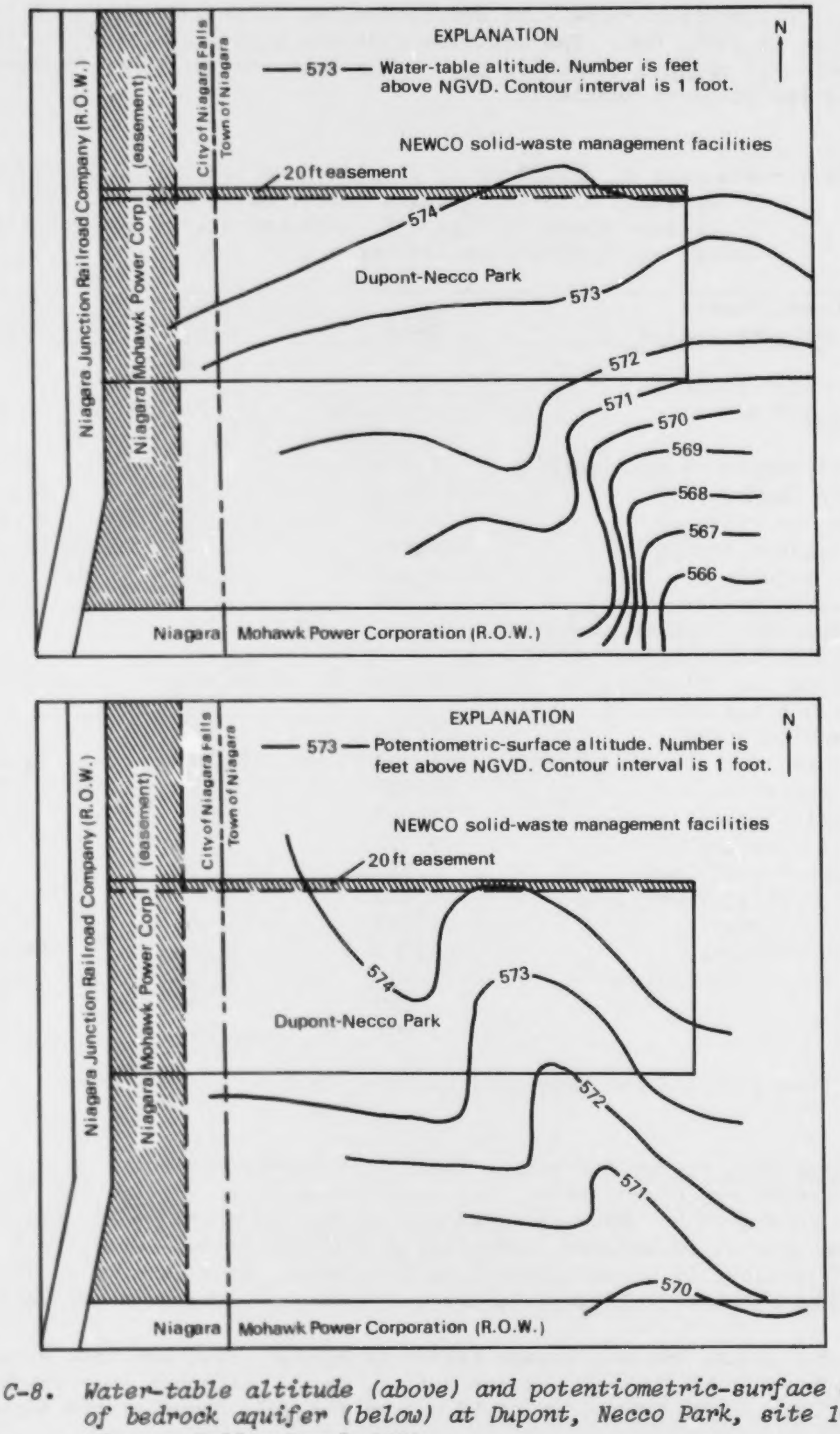

EXPLANATION
573 Water-table altitude. Number is feet above NGVD. Contour interval is 1 foot.
N
Niagara Junction Railroad Company (R.O.W.)
Niagara Mohawk Power Corp. (easement)
City of Niagara Falls
Town of Niagara
NEWCO solid-waste management facilities
20 ft easement
Dupont-Necco Park
574
573
572
571
570
569
568
567
566
Niagara Mohawk Power Corporation (R.O.W.)
EXPLANATION
573 Potentiometric-surface altitude. Number is feet above NGVD. Contour interval is 1 foot.
N
Niagara Junction Railroad Company (R.O.W.)
Niagara Mohawk Power Corp. (easement)
City of Niagara Falls
Town of Niagara
NEWCO solid-waste management facilities
20 ft easement
Dupont-Necco Park
574
573
572
571
570
Niagara Mohawk Power Corporation (R.O.W.)

Figure C-8. *Water-table altitude (above) and potentiometric-surface altitude of bedrock aquifer (below) at Dupont, Necco Park, site 14, Niagara Falls, March 1981. (Modified from Wehran, Inc., 1981.)*

Chemical information.--The site owners sampled three wells in June 1982; results are given in table C-6. The analyses indicate high concentrations of many inorganic and organic compounds from wells near the periphery, indicating the offsite migration of leachate.

Table C-6.--Analyses of ground-water samples from Lockport Dolomite at Dupont Necco Park, site 14, Niagara Falls, N.Y., June 25, 1982. [Locations shown in fig. C-7. Concentrations are in μg/kg except where otherwise indicated.][1]

Constituents or characteristics	Well numbers D-12	D-48	D-52
Ground-water altitude (ft above NGVD)	573.78	574.59	573.48
pH	7.30	7.71	5.92
Chemical oxygen demand (mg/L)	999.6	235.2	3,822
Chloride (mg/L)	1,941	2,249	80,725
Ammonia, as nitrogen	53,900	31,600	175,000
Total organic carbon	310,000	50,000	520,000
Barium, soluble	1,600	2,000	4,300,000
Halogenated organic scan (as chlorine lindane standard)	2,900	1,100	69,000
Total volatile halogenated organics (as chlorine tetrachloride standard)	272,000	54,000	105,000
Methylene Chloride	1,300	1,600	3,000
Chloroform	26,000	11,000	18,000
Carbon tetrachloride	63,000	110	14,000
1,1,2-trichloroethane	12,000	1,200	6,100
Tetrachloroethane	19,000	1,000	14,000
1,1,-dichloroethylene	530	70	130
Trans-1,2-dichloroethylene	5,400	690	2,100
Tetrachloroethylene	34,000	1,200	3,000
Trichloroethylene	45,000	18,000	14,000
Hexachloro-1,3-butadiene	700	1,100	42,000
Benzene	<50	<50	800
Toluene	100	45	590

[1] Data from Advanced Environmental Systems, Inc.

Electromagnetic survey.--The U.S. Geological Survey conducted an electromagnetic survey consisting of one line. The location is shown in fig. C-8; the data are plotted in fig. C-9. This site was one of the few areas in Niagara County in which no natural background conductivity could be found; this is attributed to the long history of waste disposal in this area. As a result, no locations along the traverse registered background or below-background conductivity.

Conductivity values, though fairly irregular, increase from west to east until just west of pumping station 2 (fig. C-9). Although an overhead cable crosses through this area, it could not be the sole cause of the high conductivity here. The probable cause is a change in the composition of buried materials or a local subsurface flow pattern. At the extreme eastern end of the traverse, the conductivity rises abruptly, probably the result of the NEWCO sanitary landfill 10 ft away.

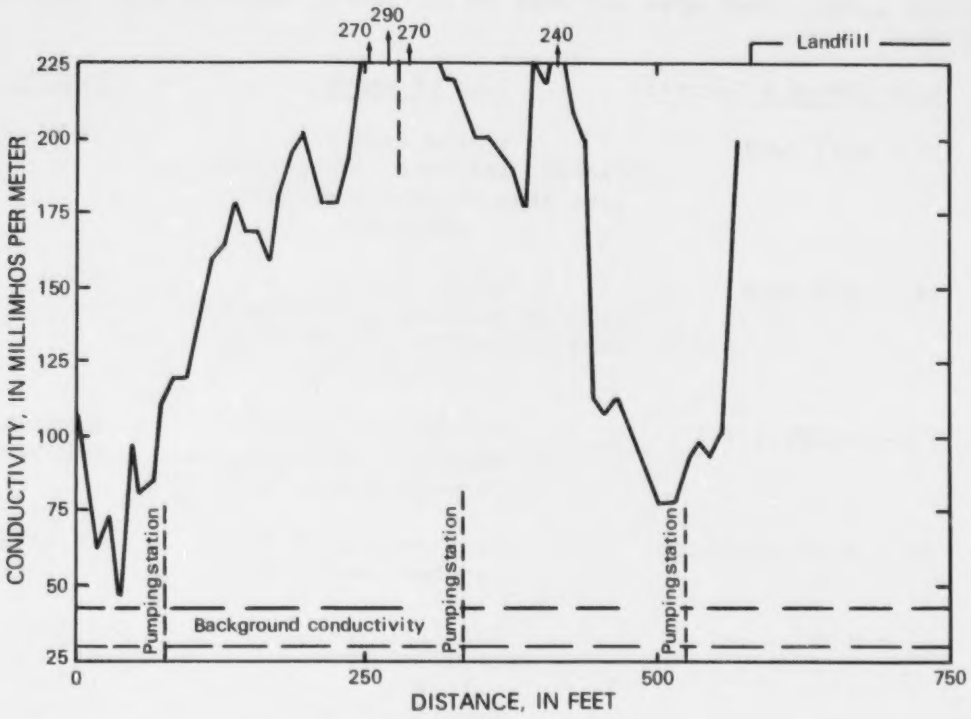


Figure C-9. Results of electromagnetic-conductivity survey for Dupont, Necco Park, site 14, Niagara Falls, N.Y.

Additional information.--Aquifer tests were conducted during the winter and spring of 1982. Since then, two wells, nos. 52 and D-12, have been pumped to control offsite leachate migration. Planned pumping rates are 5 gal/min for well D-12 and 10 gal/min for well 52. Organic-phase liquid has been detected in three wells along the southeast corner of the site. The site owner has begun an investigation to determine the lateral and vertical extent of organic-phase migration and has installed wells south of the two pumping wells to confirm the effectiveness of the pumping program in controlling offsite migration.

The site owner samples the pumping wells weekly and other wells monthly. To date, no significant trend in contaminant reduction has been noted.

Sources of data.--Weston, R. F., 1979, Hydrogeologic evaluation, Necco Park Landfill: E. I. Dupont de Nemours and Co., Niagara Falls, New York: 14 p., 6 appendices, 4 tables.

15-19, and 250. DUPONT, BUFFALO AVENUE FACILITY (Literature review) NYSDEC 932013a-f

General information and chemical-migration potential.--These three sites, which are at the Dupont Buffalo Avenue plant in the city of Niagara Falls, contain six disposal areas. Each area was used for different disposal practices, as described below:

Site number & location	Type of waste	Quantity
15 - west yard	sodium cyanide (cyanide leachate concentration less than State ground-water standard)	500 tons
16 - open dump	metal cyanide (cyanide leachate concentration less than State ground-water standard)	500 tons
17 - building 117	trichloroethylene perchloroethylene (wastes excavated)	unknown unknown
18 - south boundary	metal cyanide sludge (wastes excavated)	unknown
19 - parking lot	metal sludge cell bricks rubble demolition debris (metals concentration in soil less than background)	unknown unknown unknown unknown
250 - plant site 310	polychlorinated biphenyls (wastes excavated)	unknown

The geohydrologic setting suggests a major potential for contaminant migration. Water samples from monitoring wells along the adjacent Moses Parkway showed high concentrations of contaminants. If the direction of ground-water flow is southward toward the Niagara River, these contaminants may have come from the burial sites. Additional testing would be needed to confirm the source of contaminants. A detailed remedial investigation program by the owner is underway.

Geologic information.--The site was built on fill underlain by old river-bottom sediments of silt and clay overlying Lockport Dolomite. The depth to bedrock is approximately 10 ft.

Hydrologic information.--Hydrologic data on the individual sites are minimal. On a regional basis, ground water in the unconsolidated deposits would probably flow southward to the Niagara River or Gill Creek, whereas ground water in the bedrock would flow northwestward toward the Niagara River gorge.

Chemical information.--Recent test drilling and ground-water sampling by the U.S. Geological Survey, south of the plant, along the north side of the Parkway, indicates high concentrations of several contaminants. Well locations (RMP1 to RMP6) are shown on plate 3. The results of the ground-water analyses are given in table 18 in the main part of the report (p. 61).

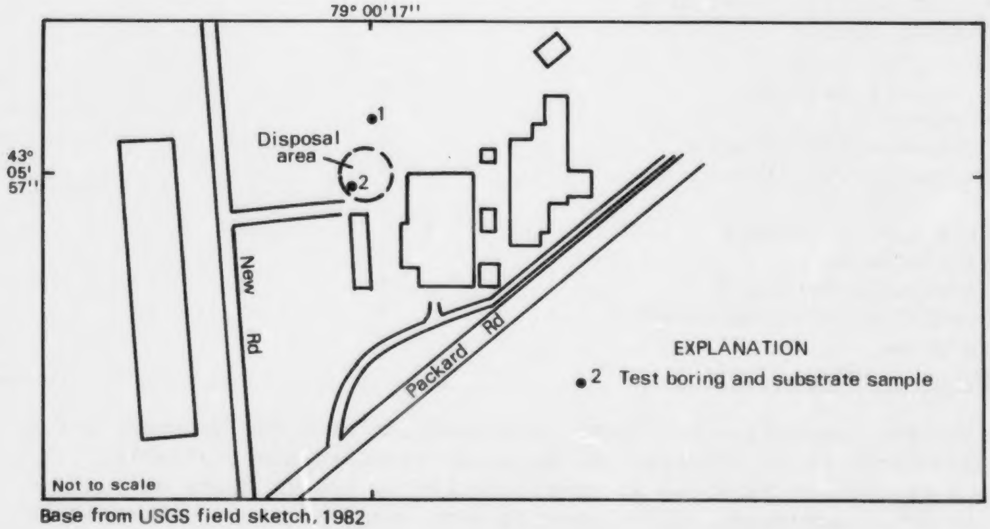
21. FRONTIER BRONZE COMPANY (USGS field reconnaissance) NYSDEC 932015

General information and chemical-migration potential.--The Frontier Bronze Company, in the city of Niagara Falls, is a storage area for spent foundry sand. The site began operation in the 1960's and continues to receive sand at a rate of 5 ton/d.

The potential for vertical contaminant migration may be high because the overburden is shallow. Some organic priority pollutants were detected in soil samples, but hydrogeologic data are lacking. The potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled two test borings on the site in 1982; locations are shown in figure C-10. The geologic log is as follows:

Boring no.	Depth (ft)	Description
1	0 - 6.2	Clay, reddish, some gravel. Bedrock at 6.2 ft. SOIL SAMPLE: 6 ft.
2	0 - 6.0	Clay, reddish; hit bedrock at 6 ft. SOIL SAMPLE: 6 ft.



Base from USGS field sketch, 1982

Figure C-10. Location of sampling holes at Frontier Bronze Company, site 21, Niagara Falls.

Hydrologic information.--No ground water was encountered during the test drilling; it is probably restricted to the fractures within the bedrock.

Chemical information.--The U.S. Geological Survey collected two soil samples for copper, iron, and organic-compound analyses; results are given in table C-7. The samples contained no phenols but contained 10 organic priority pollutants, four organic nonpriority pollutants, and some unknown hydrocarbons.

Table C-7.--Analyses of substrate samples from Frontier Bronze, site 21, Niagara Falls, N.Y.
[Locations shown in fig. C-10. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)	
First sampling (07-08-82)	1 (6.0)	2 (6.0)
Inorganic constituents		
Copper	4,000	6,000
Iron	150,000	870,000

	Sample number and depth below land surface (ft)	
Second sampling (5-26-82)	1A (4.0)	2A
Organic compounds		
Priority pollutants		
Acenaphthene	*	--
Fluoranthene	*	--
Naphthalene	*	--
N-nitrosodidi phenylamine	*	--
Benzo(a)pyrene	*	--
Acenaphthylene	*	--
Benzo(ghi)perylene	*	--
Fluorene	*	--
Dibenzo(a,h)anthracene	*	--
Indeno(1,2,3-cd)pyrene	*	--
	*	
Nonpriority pollutants		
Dibenzofuran	*	--
2-Methylnaphthalene	*	--
O-anilinophenylthiocyanate[1]	*	--
Perylene	*	--
Unknown hydrocarbons[1]	*	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

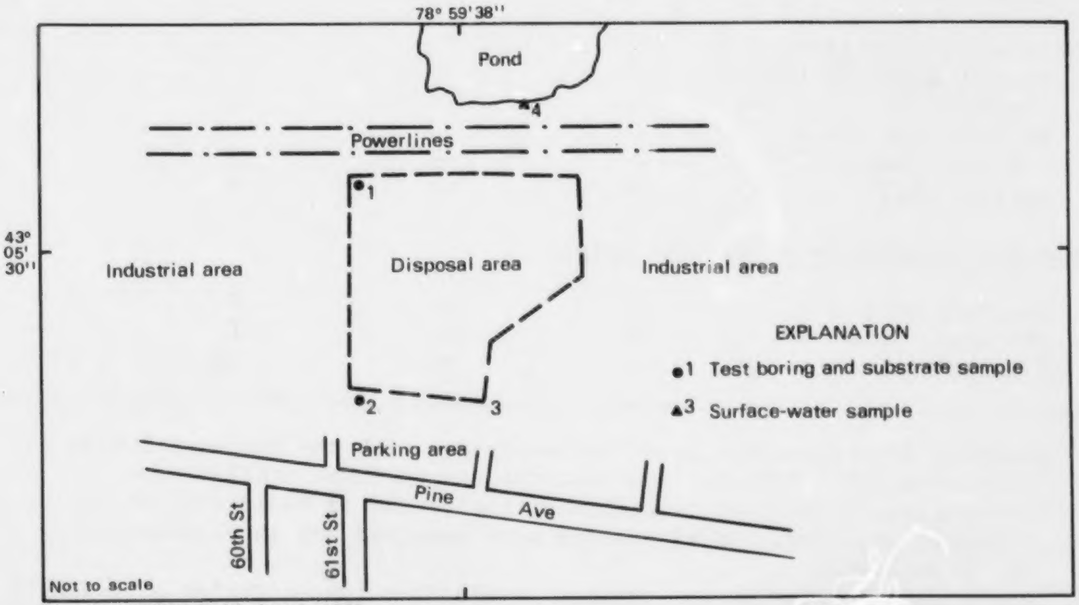
22. GREAT LAKES CARBON COMPANY (USGS field reconnaissance) NYSDEC 932016

General information and chemical-migration potential.--The Great Lakes Carbon Company, in the city of Niagara Falls, was used to dispose of unknown quantities of carbon, graphite, packing sand, and furnace bricks. These materials have been buried as fill, and the filled areas are now used for storage and other plant operations.

Chemical data suggest that the potential for contaminant migration is probably limited, but here it is considered indeterminable because other data are lacking. High concentrations of naphthalene were detected but may not indicate migration because the sample may have been taken within the disposal area. Additional sampling would be needed to confirm this, however.

Geologic information.--The site consists of a thin layer of unconsolidated material overlying Lockport Dolomite. The U.S. Geological Survey drilled three test holes on the site in 1982; the locations are shown in fig. C-11. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 4	Topsoil and carbon dust.
	4 - 6.5	Clay, greenish, wet at 5 ft.
	6.5 - 11.5	Clay, pink.
		SOIL SAMPLE: 3 - 4.7 ft.
2	0 - 2.0	Topsoil, hit somthing hard at 1.0 ft.
	2.0 - 5.0	Sand, brown to mustard, clayey, wet.
	5.0 - 6.5	Clay, tan, pink at 6.5 ft.
		SOIL SAMPLE: 2.0 ft.



Base from USGS field sketch, 1982

Figure C-11. Location of sampling holes at Great Lakes Carbon Company, site 22, Niagara Falls.

Hydrologic information.--Ground water was encountered between 2 and 4 ft below land surface. It probably represents a seasonal perched water table above the clay unit.

Chemical information.--The U.S. Geological Survey collected three soil samples and one surface-water sample for organic-compound analyses; results are given in table C-8. The samples contained four organic priority pollutants, with only naphthalene (252 µg/kg) above the quantifiable detection limit, as well as two organic nonpriority pollutants and four possibly naturally occurring organic compounds.

Table C-8.--Analyses of surface-water and substrate samples from Great Lakes Carbon, site 22, Niagara Falls, N.Y., June 28, 1982. [Locations shown in fig. C-11. Concentrations are in µg/L and µg/kg; dashes indicate that compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	Substrates		Surface water	
	1	2	3 (0.2)	4 (0.2)
Organic compounds				
Priority pollutants				
Naphthalene	252			
Anthracene	--	--	--	LT†
Fluoranthene	--	--	--	LT†
Pyrene	--	--	--	LT†
Nonpriority pollutants				
4-(1,1-dimethylethyl-phenol[1]	--	--	5	--
Butyric acid, thio, 5-decyl ester[1]	--	--	--	LT
Benzoic acid[1]	--	--	21	--
Compounds potentially of natural origin				
Hexanoic acid[1]	--	--	9	--
Pentanoic acid[1]	--	--	18	--
2-methylbutanoic acid[1]	--	--	10	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

38. OCCIDENTAL CHEMICAL, LOVE CANAL (Literature review) NYSDEC 932020

General information and chemical-migration potential.--The Occidental Chemical, Love Canal site, a 16-acre site in the city of Niagara Falls, was used during 1942-53 for disposal of industrial toxic materials and municipal waste. During this time, 21,800 tons of toxic waste were deposited. A detailed description of the type and quantity of the wastes is given below. A complete history of the site is given by U.S. Environmental Protection Agency (1982).

Type of waste	Total estimated quantity (tons)
Miscellaneous acid chlorides other than benzoyl--includes acetyl, caprylyl, butyryl, nitro benzoyls	400
Thionyl chloride and miscellaneous sulfur/chlorine compounds	500
Miscellaneous chlorination--includes waxes, oils, naphthalenes, aniline	1,000
Dodecyl (Lauryl, Lorol) mercaptans (DDM), chlorides and miscellaneous organic sulfur compounds	2,400
Trichlorophenol (TCP)	200
Benzoyl chlorides and benzotrichlorides	800
Metal chlorides	400
Liquid disulfides (LDS/LDSN/BDS)	700
Hexachlorocyclohexane (γ-BHC/Lindane)	6,900
Chlorobenzenes	2,000
Benzylchlorides--includes benzyl chloride, benzyl alcohol, benzyl thiocyanate	2,400
Sodium sulfide/sulfhydrates	2,000
Miscellaneous - 10 percent of above	2,000
Total	21,800

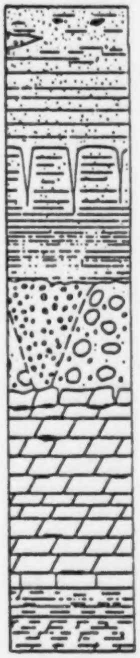
Remedial measures have been taken at the site, including the installation of a clay cap, use of a leachate-collection system, and a leachate-treatment plant. Remedial measures are also being taken under Federal Superfund Program, including cleaning of storm sewers and sanitary sewers and installation of an expanded and improved cap.

Before the leachate-collection system was installed, the geologic and hydrologic data indicated a major potential for contaminant migration. The chemical data indicated that leachate had migrated to adjacent surface water through storm sewers. Contaminants were detected in Black, Bergholtz, and Cayuga Creeks; and in the 102nd Street delta in the Niagara River.

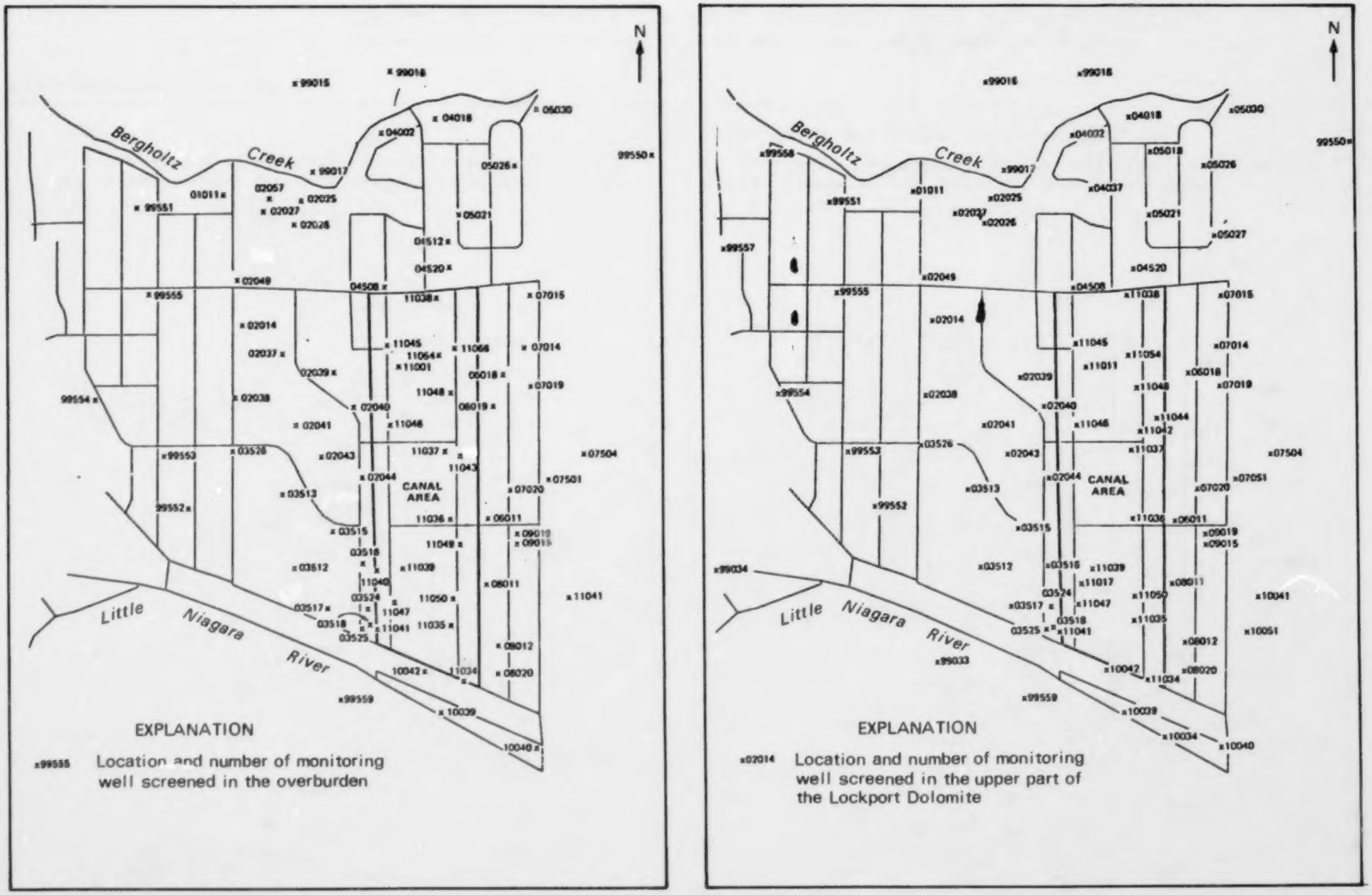
Geologic information.--The site and adjacent areas consist of fill and glacial unconsolidated deposits of lacustrine clay and till underlain by Lockport Dolomite and Rochester Shale. A summary of the units is given below.

Hydrologic information.--By 1983 a total of 174 ground-water monitoring wells had been installed in the unconsolidated deposits and bedrock; the locations are shown in figure C-12. The water levels are depicted in figure C-13.

Generalized stratigraphic column of formations underlying Occidental Chemical, Love Canal, site 38, Niagara Falls (Modified from U.S. Environmental Protection Agency, 1982.)

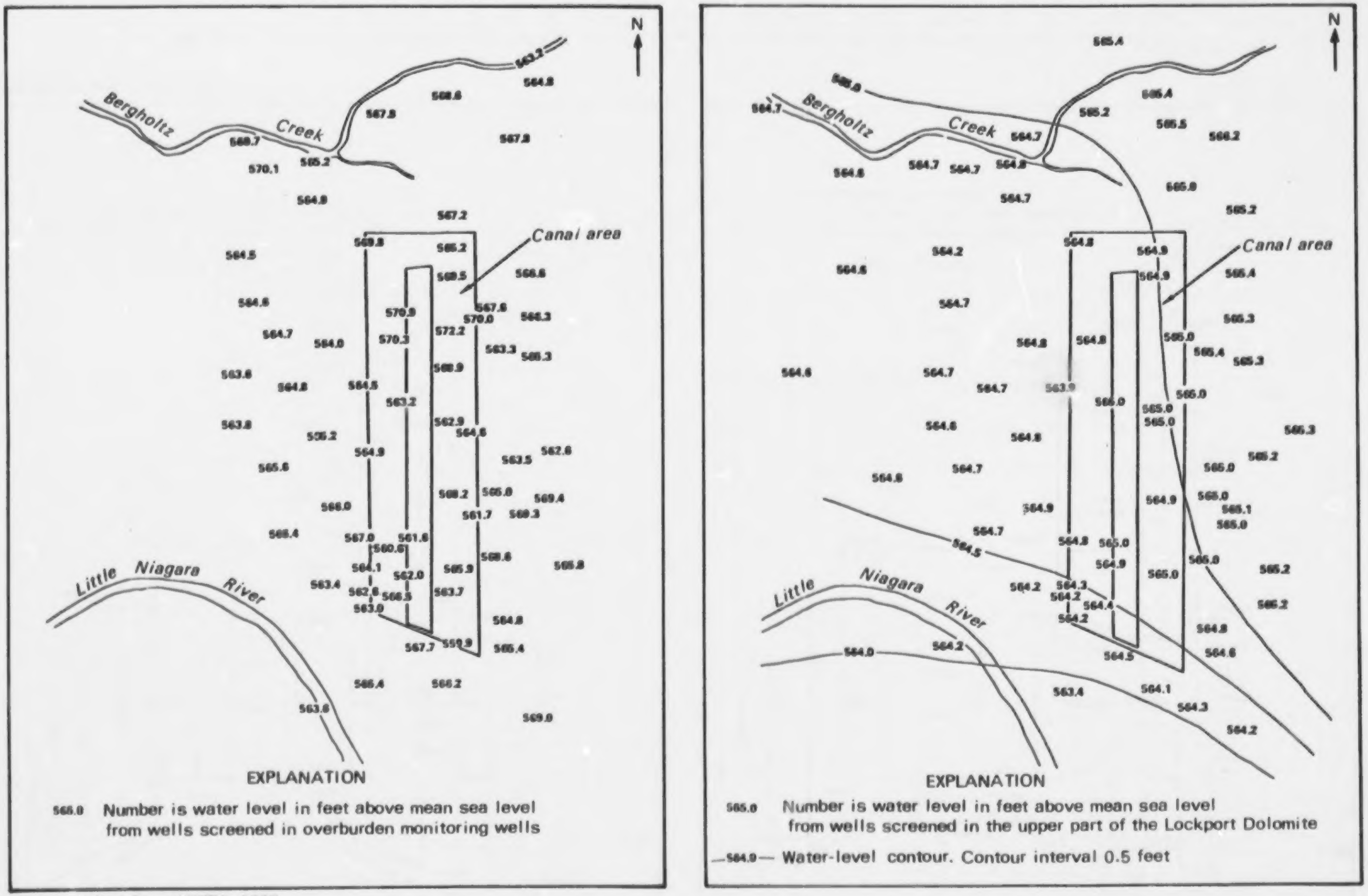


System		Formation Unit	Thickness (Feet)	General Geologic and Hydrologic Characteristics
Quaternary	Late	Fill	0.1-3	- Covers nearly entire study area - Varies from local soil material to construction rubble and industrial wastes
		Lacustrine Deposits	6-29	- Sand lenses randomly occur as elongated lacustrine deposits throughout region and consist of loamy to sandy clay; sometimes exposed at surface in undisturbed areas - Total thickness of former glacial lake deposits increases from north to south in vicinity of canal - Upper sequence deposited in former Lake Tonawanda (3-8 feet thick) is reddish brown to gray, moist, firm to very firm, varved, silty-clay to clay; dessication cracks reported in selective areas within sequence - Lower sequence (2-20 feet thick) attributable to former Lake Dana is reddish brown, very moist to wet, very plastic, very sticky, silty-clay to clay - Permeability of lacustrine deposits is generally low
		Till	1-25	- Reddish brown, moist, firm, silty to sandy clay with gravel and cobbles; sandy zones, well-sorted gravel - Two or three ridges of till oriented NE-SW are in Canal Area - Generally low permeability - Approximately 5-20 feet thick in Canal Area
Silurian	Middle	Lockport Dolomite	160-180	- Dark gray to brown, massive to thin bedded dolomite dipping at low angle to south; secondary deposits of sulfides, sulfates, and carbonates occur throughout the formation - Principal aquifer in Niagara Falls area; major producing zones in upper part of formation - Artesian and unconfined water table conditions exist associated with vertical fracture zones, cavities formed by solution of minerals and between bedding planes - Vertical joint system hydraulically connected to Niagara River
	Lower	Rochester Shale	60	- Dark-gray calcareous shale; relatively impermeable


N
Bergholtz Creek
Little Niagara River
CANAL AREA
EXPLANATION
x99555 Location and number of monitoring well screened in the overburden
N
Bergholtz Creek
Little Niagara River
CANAL AREA
EXPLANATION
x02014 Location and number of monitoring well screened in the upper part of the Lockport Dolomite

Base and data from USEPA, 1982

Figure C-12. Location of monitoring wells screened in unconsolidated deposits (left) and in bedrock (right) at Occidental Chemical, Love Canal, site 38, Niagara Falls.


N
Bergholtz
Creek
Canal area
Little
Niagara
River
EXPLANATION
565.0 Number is water level in feet above mean sea level from wells screened in overburden monitoring wells
N
Bergholtz
Creek
Canal area
Little
Niagara
River
EXPLANATION
565.0 Number is water level in feet above mean sea level from wells screened in the upper part of the Lockport Dolomite
564.9 — Water-level contour. Contour interval 0.5 feet

Base and data from USEPA, 1982

Figure C-13. Water levels in unconsolidated deposits (left) and in bedrock (right) at Occidental Chemical, Love Canal, site 38, Niagara Falls.

Field testing gave the following estimates of permeability of the various units:

lower lake deposits	10^{-8} cm/s	artificial fill	$\geq 10^{-5}$ cm/s
till	10^{-7} cm/s	upper lake deposits	10^{-7} cm/s

Pumping tests were conducted in wells tapping the Lockport Dolomite. Transmissivity was calculated to be 0.015 ft^2/s, and the storage coefficient 1.49×10^{-4} (U.S. Environmental Protection Agency, 1982).

Ground-water movement through unconsolidated deposits is probably toward Bergholtz and Black Creeks to the north, Cayuga Creek to the west, and Little Niagara and Niagara Rivers to the south. Ground-water gradients in the Lockport Dolomite indicate the direction of flow to be south and southwestward toward the Niagara River.

Flow velocities given by the U.S. Environmental Protection Agency (1982) are as follows:

- Vertical velocity in the clay is approximately 0.001 in/yr;

- Horizontal velocities in the rest of the overburden range from 1 to 60 ft/yr, depending on the permeability of the material.

Chemical information.--Extensive chemical testing has been conducted for this site, but the large quantity of data available make its inclusion in this report impractical. The data are given in Environmental Protection Agency (1982, v. I and v. II). A summary of chemical data on water from one well at the periphery of the site, provided by NYSDEC, is presented in table C-9. This well (no. 77A), was used by the New York State Department of Environmental Conservation to characterize the contaminants observed at the periphery of the site.

Sources of data.--U.S. Environmental Protection Agency, 1982, Environmental monitoring at Love Canal: EPA-600/4-82-030a-d, v. I-III, 2823 p.

Table C-9.--Chemical data from well 77A in the southwest part of site 38. [Data from USEPA, 1982.]

Priority pollutants	Concentration (µg/L) Maximum	Mean
1,1-Dichloroethethylene	1	0.5
Trans-1,2-dichloroethylene	14	8
Chloroform	80	62
Benzene	500	430
1,1,2,2-Tetrachloroethane	500	267
Tetrachloroethylene	320	186
Toluene	500	475
Chlorobenzene	500	371
Ethylbenzene	11	6
1,1,1-Trichloroethane	Trace	Trace

Table C-9.--Chemical data from well 77A in the southwest part of site 38 (continued)

Priority pollutants (continued)	Concentration (μg/L)	
	Maximum	Mean
Trichloroethylene	157	79
1,1,2-Trichloroethane	11	6
2-Chlorophenol	Trace	Trace
4-Chlorophenol	Trace	Trace
Phenol	3	3
2,4-Dichlorophenol	507	507
2,4,6-Trichlorophenol	734	734
1,4-Dichlorobenzene	190	190
1,2-Dichlorobenzene	130	130
1,2,4-Trichlorobenzene	Trace	Trace
1,3,5-Trichlorobenzene	Trace	Trace
Naphthalene	Trace	Trace
α-BHC	5	5
δ-BHC	17	17
Nonpriority pollutants		
Diethyl phthalate	Trace	Trace
3-Chlorotoluene	500	500
4-Chlorotoluene	500	328
m-Xylene	2	2
p and o-Xylene	1	1
4-Chlorophenol	Trace	Trace
2,4,6-Trichloroaniline	Trace	Trace
1,2,3,4-Tetrachlorobenzene	Trace	Trace
2-Chlorotoluene	304	152

39. OCCIDENTAL, HYDE PARK LANDFILL (Literature review) NYSDEC 932021

General information and chemical-migration potential.--The Occidental Hyde Park landfill, a 15-acre site in the northwest corner of the town of Niagara, was active during 1953-75 and was used for disposal of 80,000 tons of chemical wastes related to production of fertilizers, plastics, and various industrial products. Typical wastes deposited are listed in table C-10. The landfill was clay capped, and a leachate-collection system was installed in 1979.

Chemical analyses of ground water from several wells suggest some migration of leachate away from the burial area, but the lateral and vertical extent of contaminant movement is not known. The log of one well describes a slurry of mixed chemicals as deep as 26 ft below the top of the fill. Contaminants have also been detected in ground water from 50 ft below the top of the Lockport Dolomite, and nonaqueous chemicals have been found at this depth at a distance of 700 ft from the site. Recent chemical data indicate that contaminants have migrated through the full thickness of the Lockport Dolomite. Well locations are shown in figure C-14.

Contaminants in the upper unconsolidated deposits (lake deposits and till) move slowly because the permeability of these deposits is low. The leachate-collection system and clay cap would help deter horizontal contaminant movement, but some contaminants could move vertically downward and enter the more permeable Lockport Dolomite. Johnston (1982) estimated that ground water in the Lockport Dolomite in the area would take 4.9 years to reach the Niagara River gorge, 3,000 ft to the northwest. Leachate may not move at the same rate as uncontaminated ground water, however, and more data would be needed on the flow regime of both the Lockport Dolomite and the underlying Rochester Shale to determine the vertical and horizontal flow components. Water levels in wells completed in the unconsolidated deposits and in bedrock near the landfill indicate gradients to be west-northwest toward the Niagara River gorge. The site has a major potential for contaminant migration.

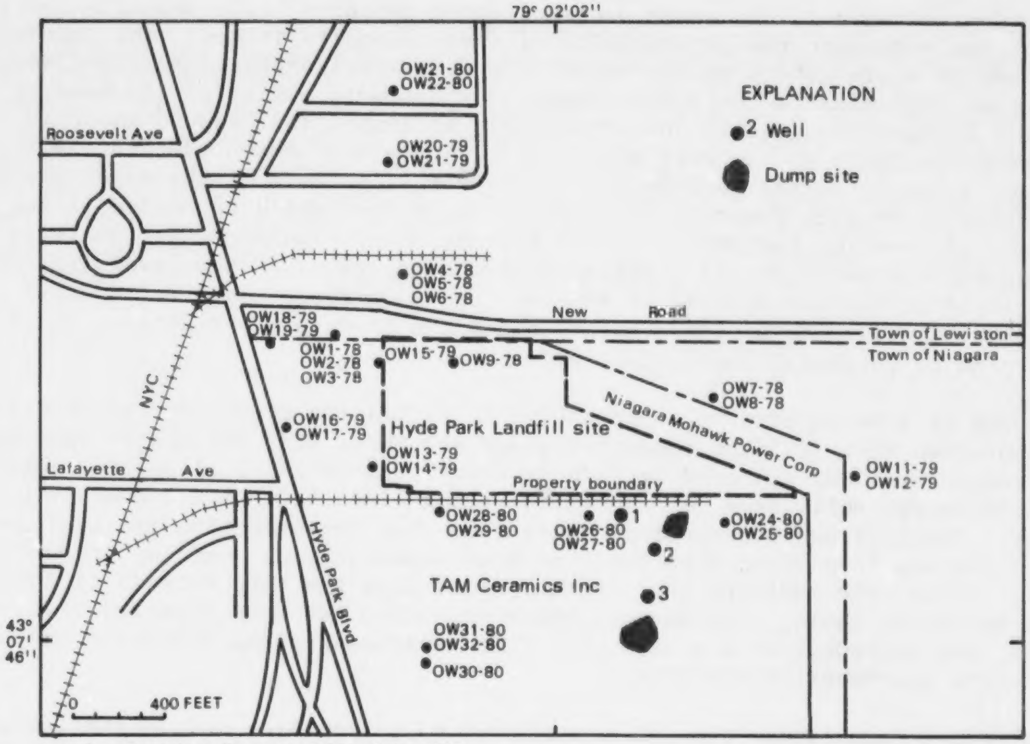
The site is undergoing an intensive investigation by Occidental Chemical Corporation that is being conducted under the terms of a negotiated settlement agreement that was approved by Federal Court. As of 1983, 47 bedrock wells and 13 overburden wells have been installed along lines radiating outward from the site. Chemical and hydrogeologic data from this investigation are available from the New York State Department of Environmental Conservation, in Buffalo, N.Y. These data indicate that contamination from the site extends to the top of the Rochester Shale, that aqueous-phase migration has been detected east, northwest, and southwest of the site, and that nonaqueous-phase migration has been detected southwest of the site.

Geologic information.--Glacial deposits 10 to 35 ft thick and consisting of till and lacustrine clay, silt, and fine sand overlie the Lockport Dolomite. Pebbles occur sporadically in lake sediments, which might indicate this deposit to be a till (reworked lake deposit).

The Lockport Dolomite in this area ranges from 90 to 130 ft in thickness. Depth to bedrock is generally less than 15 ft east of the landfill, and increases to about 35 ft west of the landfill. The upper 10 to 15 ft is the most permeable zone (Johnston, 1982). Underlying the Lockport Dolomite is the Rochester Shale, a relatively impermeable unit. Bedrock-surface contours in the site vicinity are shown in figure C-15.

Table C-10.--Type of chemical wastes deposited at the Occidental Chemical-Hyde Park Landfill, site 39, Niagara, N.Y., 1953-79.[1]
[Data from New York State Department of Environmental Conservation.]

- Calcium fluoride
- Hexachlorocyclopentadiene derivatives
- Mercury brine sludge
- Organic phosphates
- Dechlorane
- Benzotrichloride
- Chlorotoluenes
- Chlorindic acid ($C_9H_4O_4Cl_6$)
- Dodecylmercaptan
- Trichlorophenol
- Benzotrifluoride derivatives
- Benzoyl chloride
- Liquid disulfides, chlorotoluene based disulfides
- Chlorobenzenes
- Benzyl chloride
- Thiodan
- Miscellaneous chlorinations
- Acid chlorides



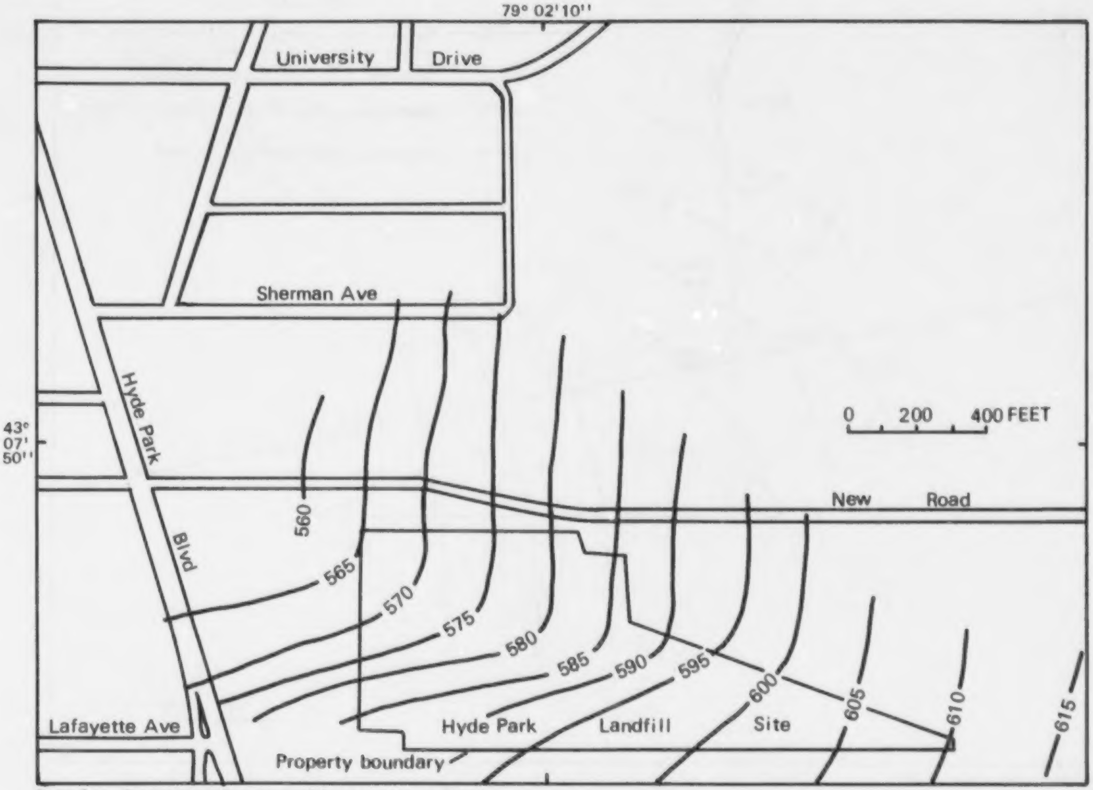
Base from Conestoga, Rovers, and Associates, 1980

Figure C-14. Location of monitoring wells, Occidental Chemical--Hyde Park Landfill, site 39, Niagara Falls.

Hydrologic information.--The ground-water flow system in the area is described by Johnston (1982) as a horizontally layered system bordered on three sides by ground-water drains. These drains are (1) the Niagara River Gorge to the west, which penetrates below the Rochester shale; (2) the canal of the Niagara River Project to the north, which penetrates the Rochester shale; and (3) the buried conduits of the power project to the east, which fully penetrate the Lockport Dolomite. Ground-water recharge is estimated to be slightly less than 6 in/yr (Johnston, 1982). Ground water entering the area moves to one of these three discharge areas.

The ground-water flow regime was modeled by Johnston (1982), who suggests that ground water in the immediate vicinity of the landfill in the upper 10 to 15 ft of the Lockport Dolomite flows northwest toward the Niagara River. The potentiometric surface and direction of ground-water flow in the upper part of the Lockport Dolomite is shown in fig. C-16.

Johnston's ground-water model indicates a ground-water divide east of the landfill; ground water east of the divide flows eastward toward the conduits, while ground water west of the divide flows northwestward toward the Niagara

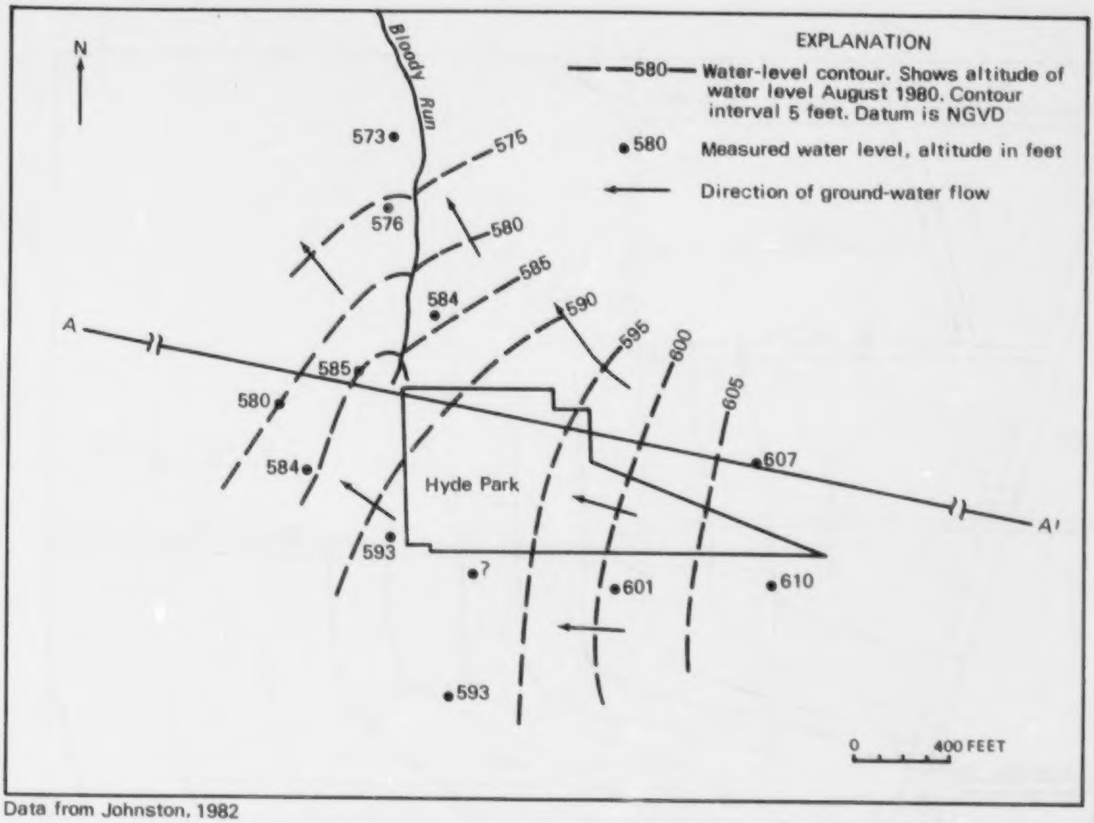


Base from Conestoga, Rovers, and Associates, 1980

Figure C-15. Altitude of top of the Lockport Dolomite, Occidental Chemical--Hyde Park Landfill, site 39, Niagara Falls. (Modified from Conestoga-Rovers and Associates, 1982.)

River gorge. The model also indicates that ground water in the lacustrine unit and till near the landfill flows horizontally (northwestward) and downward into the Lockport Dolomite. Permeabilities calculated from pumping tests of wells tapping the overburden or bedrock-till interface are given in table C-11. West of the landfill, ground water in the unconsolidated deposits flows mainly downward.

The flow regime of the bedrock aquifer is controlled mainly by the distribution of joints and fractures. The upper 10 to 15 ft of the Lockport Dolomite is highly fractured and is the most permeable zone in the area (Johnston, 1964). Beneath this zone, the joints are narrower, although some horizontal bedding planes are partly open. Ground water in the upper Lockport layers flows northwestward horizontally to the vicinity of the Niagara River gorge, where weathering of the gorge wall has increased the vertical and horizontal fracturing and allows ground water to move downward (Johnston, 1982). Installation of piezometers as close as possible to the gorge wall could verify this interpretation. Most ground water flows through the upper and lower Lockport Dolomite; only a small percentage moves through the Rochester shale and the unconsolidated deposits.


N
Bloody Run
EXPLANATION
580 Water-level contour. Shows altitude of water level August 1980. Contour interval 5 feet. Datum is NGVD
● 580 Measured water level, altitude in feet
Direction of ground-water flow
573
575
576
580
585
584
590
595
600
605
A
A'
585
580
584
607
Hyde Park
593
?
601
610
593
0
400 FEET

Data from Johnston, 1982

Figure C-16. Water levels in upper part of Lockport Dolomite, Occidental Chemical--Hyde Park Landfill, site 39, Niagara Falls.

Estimated traveltimes for ground water to move the 3,000 feet from the landfill to the gorge through the respective units are as follows: till, 490 years; upper Lockport Dolomite, 4.9 years; lower Lockport Dolomite, 6.0 years. Estimated traveltime to move vertically to the bottom of the Rochester shale is 38 years (Johnston, 1982).

Chemical information.--Many ground-water samples have been collected on and near the site; results of analyses are given in several progress reports by Conestoga-Rover and Associates (1979a, b, c; 1980). In addition, the U.S. Environmental Protection Agency has collected soil and water samples along the Niagara River gorge; results are given in a report by West Coast Technical Service, Inc. (1982). The site is currently undergoing extensive sampling by the owner.

The data collected thus far indicate that leachate generated in the landfill has infiltrated through the overburden and into upper part of the Lockport Dolomite. Elevated concentrations of heavy metals and organic compounds have been found in both units.

Table C-11.--Permeability of overburden at Occidental Chemical-Hyde Park Landfill, site 39, Niagara Falls, N.Y.
[Locations are shown in fig. C-18. Data from Conestoga-Rovers and Associates, 1978.]

Well number[1]	Average K (permeability factor (cm/s)	Location of screen
OW 2-78	7.0×10^{-7}	overburden
OW 3-78	4.9×10^{-7}	interface
OW 5-78	7.3×10^{-5}	interface
OW 6-78	9.4×10^{-5}	overburden
OW 8-78	9.8×10^{-6}	interface
OW 9-78	8.9×10^{-7}	overburden
OW 10-78	6.0×10^{-6}	interface

[1] Observation wells drilled in 1978.

Sources of data

Anderson, E. G., 1982, Hydrogeology review, Hyde Park Landfill: Ontario, Canada, Gartner Lee and Associates, 19 p.

Conestoga-Rovers and Associates, 1979a, Progress report I, Hyde Park Landfill: Waterloo, Ontario, Candada, 17 p.

__________1979b, Progress report III, Hyde Park Landfill, Bloody Run, and 102nd Street Landfill, Waterloo, Ontario, Canada, 27 p.

__________1979c, Progress report IV, Hyde Park Landfill and Bloody Run: Waterloo, Ontario, Canada, 33 p.

__________1979d, Progress report V, Hyde Park Landfill, Bloody Run and 102nd Street Landfill: Waterloo, Ontario, Canada, 23 p.

__________1980, Progress report VIIIA, Hyde Park-Bloody Run: Waterloo, Ontario, Canada, 18 p.

Johnston, R. H., 1964, Ground water in the Niagara Falls area: New York Water Resources Commission Bulletin GW-53, 93 p.

Masila, M. L., and Johnston, R. H., 1982, Simulation of ground-water flow in the vicinity of Hyde Park Landfill, Niagara Falls, New York: U.S. Geological Survey Open-File Report 82-159, 19 p.

West Coast Technical Service, Inc., 1982, Final report to the U.S. Environmental Protection Agency (Water and soil samples from the Niagara River Gorge): Cerritos, Calif., 78 p.

40. OCCIDENTAL CHEMICAL COMPANY 102nd Street Site (Literature review) NYSDEC 932022

General information and chemical-migration potential.--The Occidental Chemical Company site, a 14-acre site in the city of Niagara Falls, was used during 1943-71 to dispose of the materials listed below. The site is currently (1984) under litigation for cleanup and remedial action.

organic phosphates	100 tons
sodium hypophosphites	20,000 tons
inorganic phosphates	300 tons
BHC cake	300 tons
chlorobenzenes	100 tons
Miscellaneous (10 percent, includes other chlorinated organic compounds)	2,200 tons
TOTAL	23,000 tons

Hydrogeologic data indicate a major potential for contaminant migration. The fill overlies an alluvial deposit that is probably in hydraulic contact with the river. Recent ground-water-level monitoring by the company has indicated that ground-water flow is southward toward the Niagara River. Chemical sampling of ground water on- and offsite has indicated that migration is occurring.

Geologic information.--The site consists of fill overlying alluvial deposits that are underlain by a glaciolacustrine clay. The clay overlies a thin layer of till that overlies bedrock of Lockport Dolomite.

Twenty-four test borings were drilled on the site, the geologic logs are given in Conestoga-Rovers and Associates (1980).

Hydrologic information.--Water levels were measured periodically from August 1979 through March 1980 and are reported by Conestoga-Rovers and Associates (1980). A few localized ground-water mounds have been detected in which water levels are higher than the river stage. Recent studies by the company indicate that ground water flows southward from the site to the river, which is also the ground-water flow direction at adjacent sites.

Chemical information.--No chemical information on the site was available in 1983.

Sources of data

Conestoga-Rover and Associates, 1979a, Site investigation and monitoring program, 102nd Street Landfill, Hooker, Niagara Falls, New York: 20 p., 2 maps.

_________1979b, Progress report V, Hyde Park Landfill, Bloody Run, 102nd Street Landfill, Hooker, Niagara Falls, New York: 23 p., 6 tables, 3 maps, 3 appendices.

_________1979c, Progress Report VI, Hyde Park Landfill, Bloody Run, 102nd Street Landfill, Hooker, Niagara Falls, New York: 18 p., 1 appendix, 1 map.

Sources of data (continued)

________1980, Progress Reports VIIIB, 102nd Street Landfill, Hooker, Niagara Falls, New York: 2 p., 2 tables, 1 appendix.

Neruda, F. D.,1980, Niagara Frontier inactive waste disposal sites, Hyde Park Landfill, Bloody Run, 102nd Street Landfill, 'S' Area Landfill, site conditions and proposed remedial action: Niagara Falls, N.Y., Hooker, 31 p., 14 figs., 1 appendix.

41a. OCCIDENTAL CHEMICAL-BUFFALO AVENUE, S-AREA NYSDEC 932019-a
(Literature review)

General information and chemical-migration potential.--The S-area, a 16-acre landfill in the southeast corner of the Hooker-Buffalo Avenue plant, was used to dispose of 63,100 tons of organic phosphates, acid chlorides, phenol tars, thionyl chloride, chloridic acid ($C_9H_4O_4Cl_6$), trichlorophenol, benzoyl chloride, liquid disulfides and chlorotoluene-based disulfides, metal chlorides, thiodan, chlorobenzenes, and miscellaneous chlorinated hydrocarbons.

In 1978, organic chemicals were discovered in the shore shaft intake structure and forebay of the City of Niagara Falls water-treatement plant. The contamination was traced to this site. The site is currently undergoing Federal and State litigation.

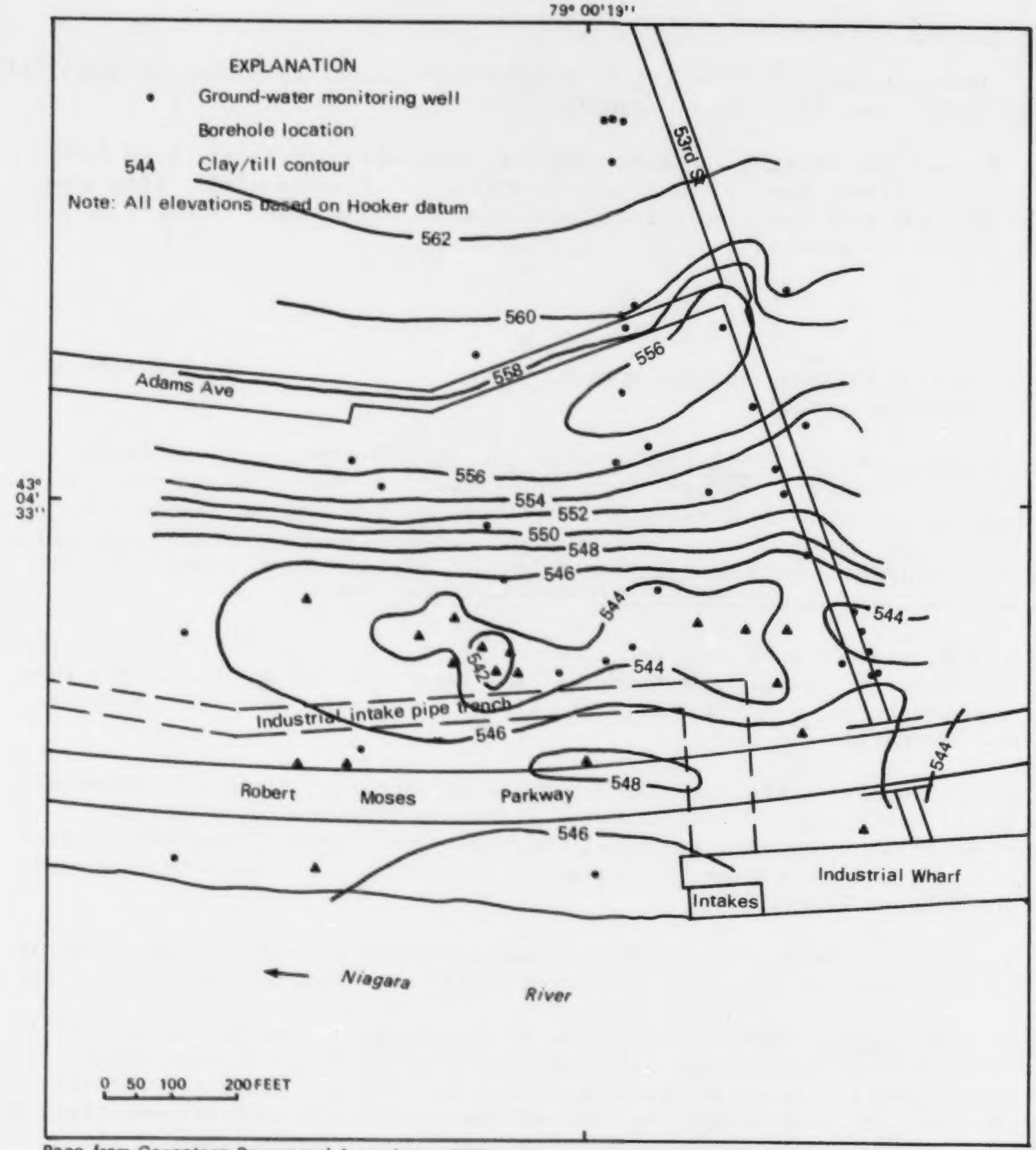
Data collected on the site and along its perimeter indicate that chemical migration is occurring and that remedial action is required; thus the contaminant-migration potential is major. Data are insufficient, however, to evaluate the rates and quantities of contaminant migration into the bedrock aquifer or to the Niagara River.

The State and Federal Governments have negotiated with Occidental Chemical Corportion to reach an agreement for investigation and remediation of the site.

Geologic information.--The site consists of fill ranging from 8.5 to 17.5 ft in thickness and overlying natural sand and silt deposits 14 to 17.5 ft thick. Below these deposits is a till stratum 1 to 5 ft thick and composed predominantly of silt and rock fragments. The unconsolidated deposits are underlain by Lockport Dolomite. Maps showing the surface altitude and thickness of the clay/till unit are given in figures C-17 and C-18; a map of the bedrock-surface altitude is shown in fig. C-19.

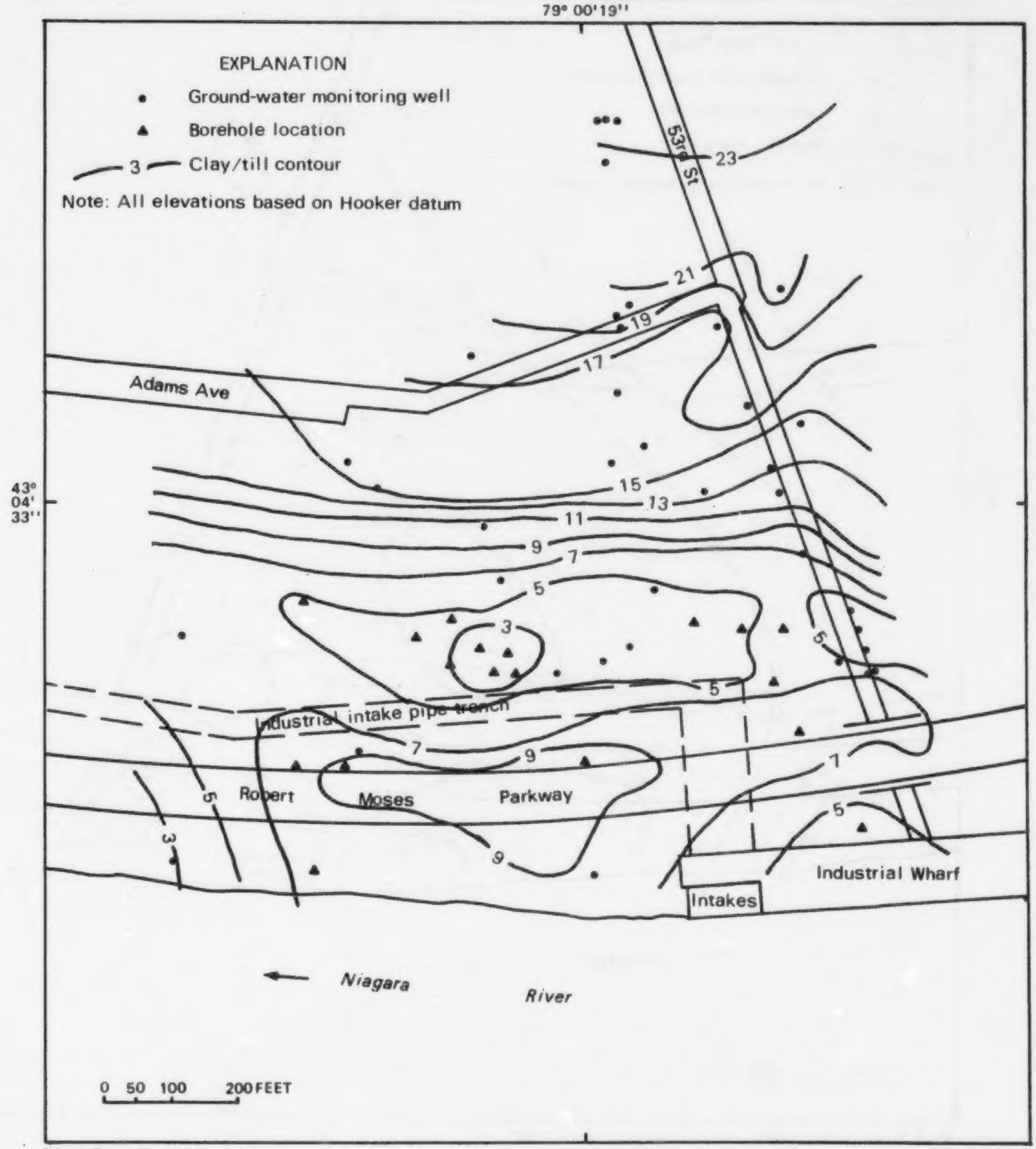
Hydrologic information.--Water-level and permeability data are available in several reports by consultants. The data (not included herein) are summarized below.

Measured water levels in the overburden wells in February 1980 were used to construct a water-table map (fig. C-20). The map indicates a ground-water mound with a maximum altitude of 572 ft above NGVD, which suggests that ground-water flow at this site is essentially radial.



Base from Conestoga-Rovers and Associates, 1982

Figure C-17. Altitude of top of clay/till unit, Occidental Chemical--Buffalo Avenue, S-area, site 41a, Niagara Falls.



Base from Conestoga-Rovers and Associates, 1982

Figure C-18. Thickness of clay/till unit, Occidental Chemical--Buffalo Avenue, S-area, site 41a, Niagara Falls.

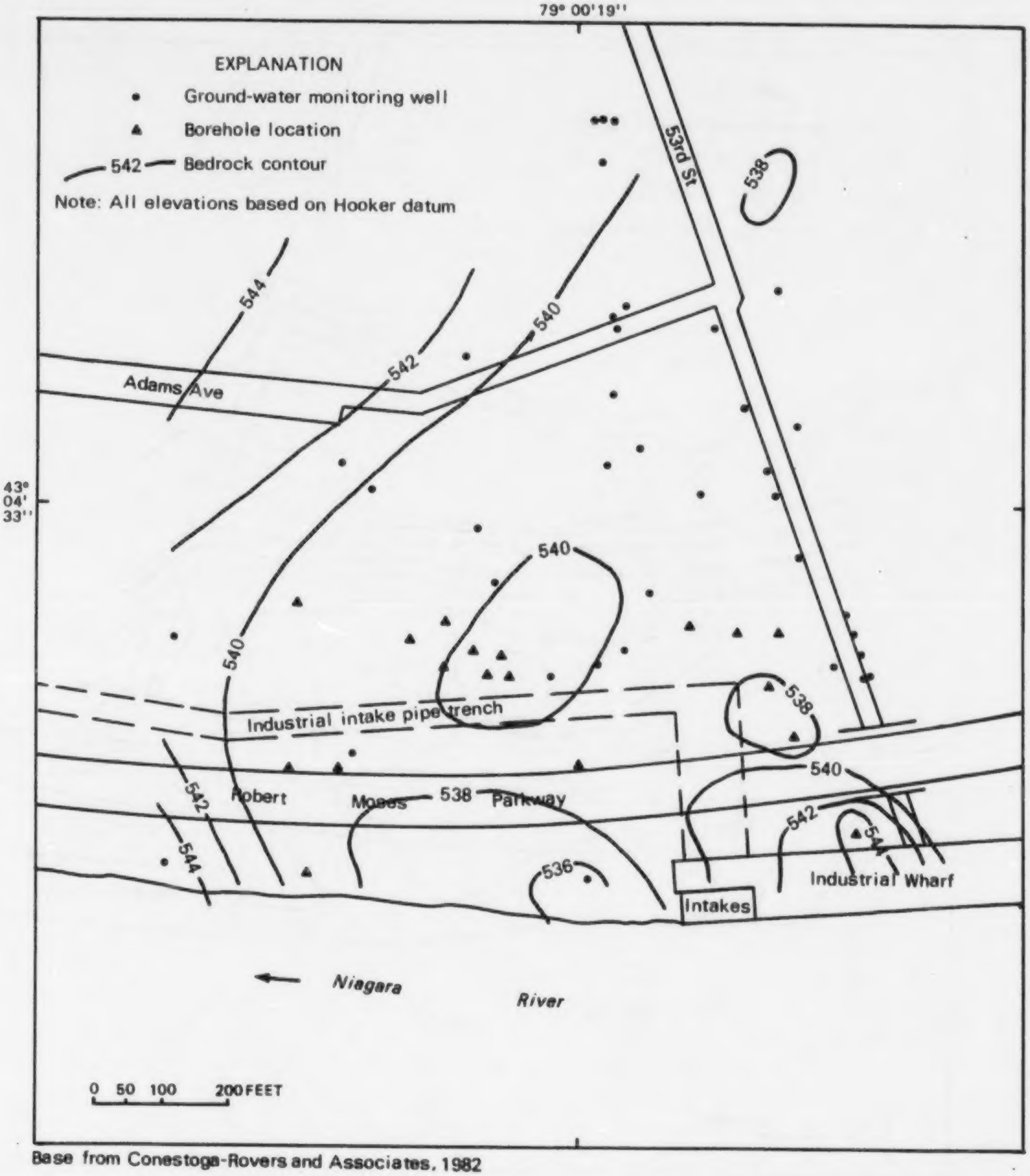
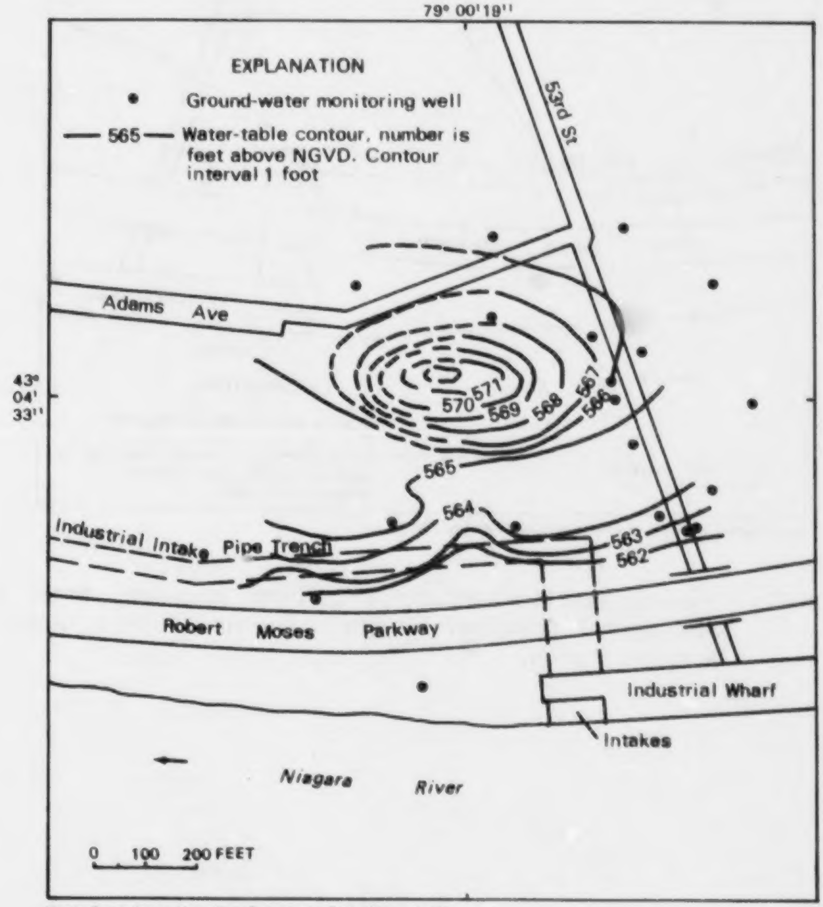


Figure C-19. Bedrock-surface altitude, Occidental Chemical--Buffalo Avenue, S-area, site 41a, Niagara Falls.

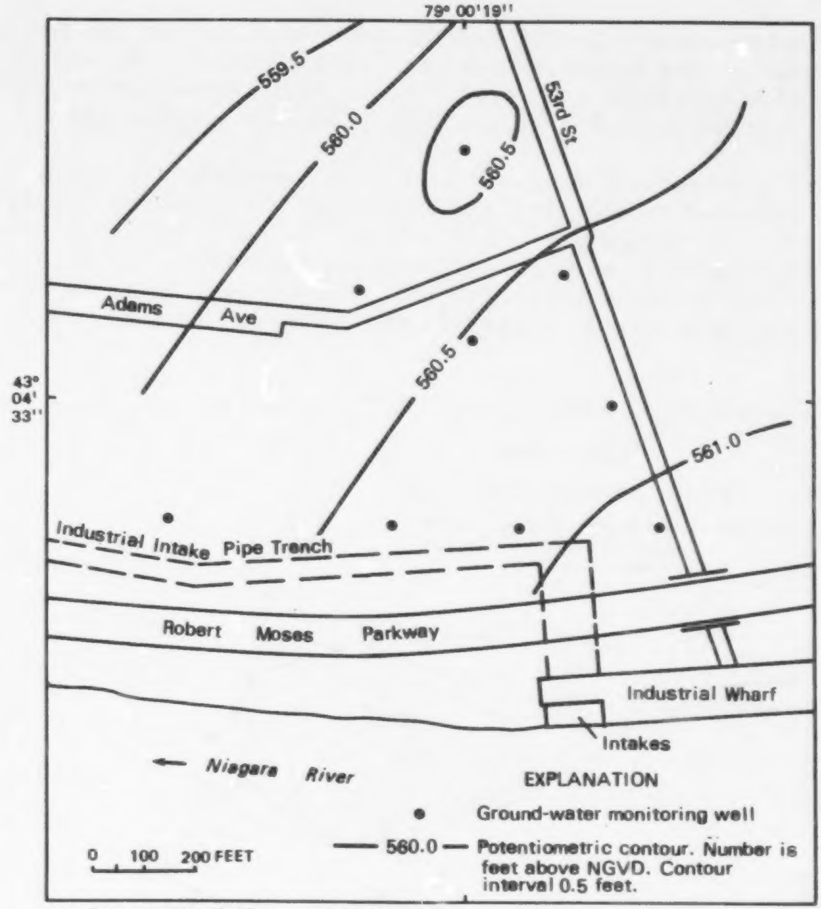
Water levels measured in observation wells screened in the bedrock yielded the values shown on the potentiometric map in fig. C-21. The map indicates that ground-water flow is toward the northwest. A small ground-water mound of 0.5 ft is indicated, but additional data would be needed to confirm it.

Leggette, Brashears, and Graham (1980) ran permeability tests at observation wells screened in the fill and overburden and obtained permeability values of 0.10 to 10 (gal/d)/ft^2 (5×10^{-4} to 5×10^{-6} cm/s) for the lower overburden stratum of very fine sand and 70 to 100 (gal/d)/ft^2 (3×10^{-3} to 5×10^{-3} cm/s) for the upper stratum of fill. These values indicate that ground water would move considerably faster in the fill than in the underlying material.



Base from Leggette, Brashears, and Graham, 1980

Figure C-20. Water levels of February 1980 in the S-area, Occidental Chemical--Buffalo Avenue, site 41a, Niagara Falls.



Base from Leggette, Brashears, and Graham, 1979

Figure C-21. Potentiometric surface of bedrock aquifer, April 1979, Occidental Chemical--Buffalo Avenue, S-area, site 41a, Niagara Falls.

Chemical information.--Extensive chemical data are given in unpublished reports by consultants for Federal, State, and local agencies involved in the litigation proceedings.

Chemical data from samples collected by the site owner from a well south of the Robert Moses Parkway along the Niagara River and wells along the southern part of the S-Area indicate high concentrations of organic contaminants. The compounds and their concentration maximums and means are as follows:

Priority pollutants	Concentration(μg/L) Maximum	Concentration(μg/L) Mean
trans-1,2,-Dichloroethylene	261	162
Chloroform	1,750	530
Trichloroethylene	6,870	1,774
Benzene	3,860	1,799
Toluene	1,420	588
Chlorobenzene	4,160	1,781
Phenol	2,990	1,184
Dichlorobenzenes	2,980	758
Hexachloroethane	4,450	912
Hexachlorobutadiene	22,800	4,995
Hexachlorocyclopentadiene	12,000	2,400
Hexachlorobenzene	25,200	5,319
Carbon tetrachloride	7,400	1,496
Trichlorophenols	1,280	257
Mirex	1,610	463
1,1,2,2-Tetrachloroethylene	15,400	5,621
Nonpriority pollutants		
Trichlorobenzenes	50,400	11,318
Tetrachlorobenzenes	223,000	45,521
Monochlorotoluenes	9,300	2,264
Dichlorotoluenes	5,840	1,271
Octachlorocyclopentene	15,000	3,000
Pentachlorobenzene	1,200	255

Data from Occidental Chemical Corporation, 1983.

Sources of data

Conestoga-Rovers and Associates, 1982, Overburden investigation, S-area, December 1981 to March 1982: Waterloo, Ont., Conestoga-Rovers and Associates.

Leggette, Brashears, and Graham, 1979, Shallow ground-water quality investigation, Hooker Chemicals and Plastics Corp., Niagara Falls, New York plant: Westport, Conn., Leggette, Brashears, and Graham, Inc., Progress Report 2, 7 p., 8 figs., 3 append.

41b-49. OCCIDENTAL CHEMICAL--BUFFALO AVENUE PLANT, (Literature review) NYSDEC 932019b-i

General information and chemical-migration potential.--Occidental Chemical-Buffalo Avenue Plant sites 41b through 49 are considered together herein because of their proximinity to one another. The sites contain mostly unknown quantities of organic chemicals, metals, chlorides, sulfides, and phosphorus compounds.

Approximately 120 monitoring wells have been installed by the site owners to determine the hydraulic gradients and extent of ground-water contamination.

Hydrogeologic data indicate a major potential for lateral contaminant migration, but clay deposits underlying the site would retard downward movement of contaminants into the bedrock. Offsite migration is occurring as a result of ground-water infiltration into sewerlines. Ground-water sampling would be needed to determine the rate and extent of the migration, however. These sites are the subject of New York State litigation.

Geologic information.--Approximately 120 geologic logs of wells and borings in and around the sites are published in a report by Leggette, Brashears, and Graham, Inc., (1980).

During postglacial time, the Niagara River flowed over the southern part of the site. North of this area the site consists of poorly sorted till, averaging 13 ft in thickness, that overlies very fine sand and (or) a clay layer averaging 6 ft thick. These layers are underlain by till that, in turn, overlies the Lockport Dolomite (Leggette, Brashears, and Graham, Inc., 1978). South of the ancient shoreline, the clay is mostly absent, and the till also thins or is absent; consequently the very fine sand and till are thicker (Leggette, Brashears, and Graham, Inc., 1979). Geologic cross sections of the southern and eastern plant boundaries are shown in Leggette, Brashears, and Graham, Inc. (1979).

Hydrologic information.--Water levels in wells installed in the unconsolidated deposits indicate some ground-water mounds, but the main direction of flow is southward toward the Niagara River (fig. C-22 and C-23. Permeability measurements were made at 13 wells (table C-12), and artificial fill was found to be the most permeabile unit at most locations. Permeability of the clay and till was not evaluated.

Water levels in wells tapping the Lockport Dolomite indicate ground water to be moving northwestward, away from the Niagara River (fig. C-24). At these sites, the Lockport Dolomite is recharged by the Niagara River, and water levels in wells tapping the Lockport Dolomite fluctuate with the river stage and at approximately equal altitudes, indicating a hydraulic connection between bedrock and the river (Leggette, Brashears, and Graham, 1979). Water-level measurements in the Lockport Dolomite were not obtained far enough north of the site to determine the extended path of ground-water migration or eventual discharge area. Ground water may flow north-northwest to the Niagara Falls sewer system, which then drains to the west toward the gorge.

Chemical information.--The site owner sampled 11 plant-site wells tapping the unconsolidated deposits along the Robert Moses Parkway from May to July, 1980; results indicate highly elevated levels of organic contaminants:

Priority pollutants	Concentration Maximum	(µg/L) Mean
Trichloroethylene	400,000	71,790
Tetrachloroethylene	32,000	7,120
Toluene	2,940	435
Dichlorobenzene	31,000	5,830
Nonpriority pollutants		
Monochlorobenzene	1,025	255
Chlorobenzotrifluoride	400	112
Chlorotoluene	79,000	10,500
Dichlorotoluene	14	12
Trichlorobenzene	150	44
Tetrachlorobenzene	240	125

Data from Occidental Chemical Co.

Sources of data

Conestoga-Rovers and Associates, 1981, Monitoring well installation details, monitoring well water elevations, Hooker Buffalo Avenue plant and Drinking Water Treatment Plant: Toronto, Conestoga-Rovers and Associates, 25 p.

Leggette, Brashears, and Graham, Inc., 1979, Shallow ground-water quality investigation, Hooker Chemical and Plastics Corp., Niagara Falls, New York Plant: Westport, Conn., Leggette, Brashears, and Graham, Inc., Progress Report 1, 4 p., 13 figs., 1 appendix.

__________1979, Shallow ground-water quality investigation, Hooker Chemicals and Plastics Corp., Niagara Falls, New York Plant: Westport, Conn., Leggette, Brashears, and Graham, Inc., Progress Report 2, 7 p., 8 figs., 3 appendices.

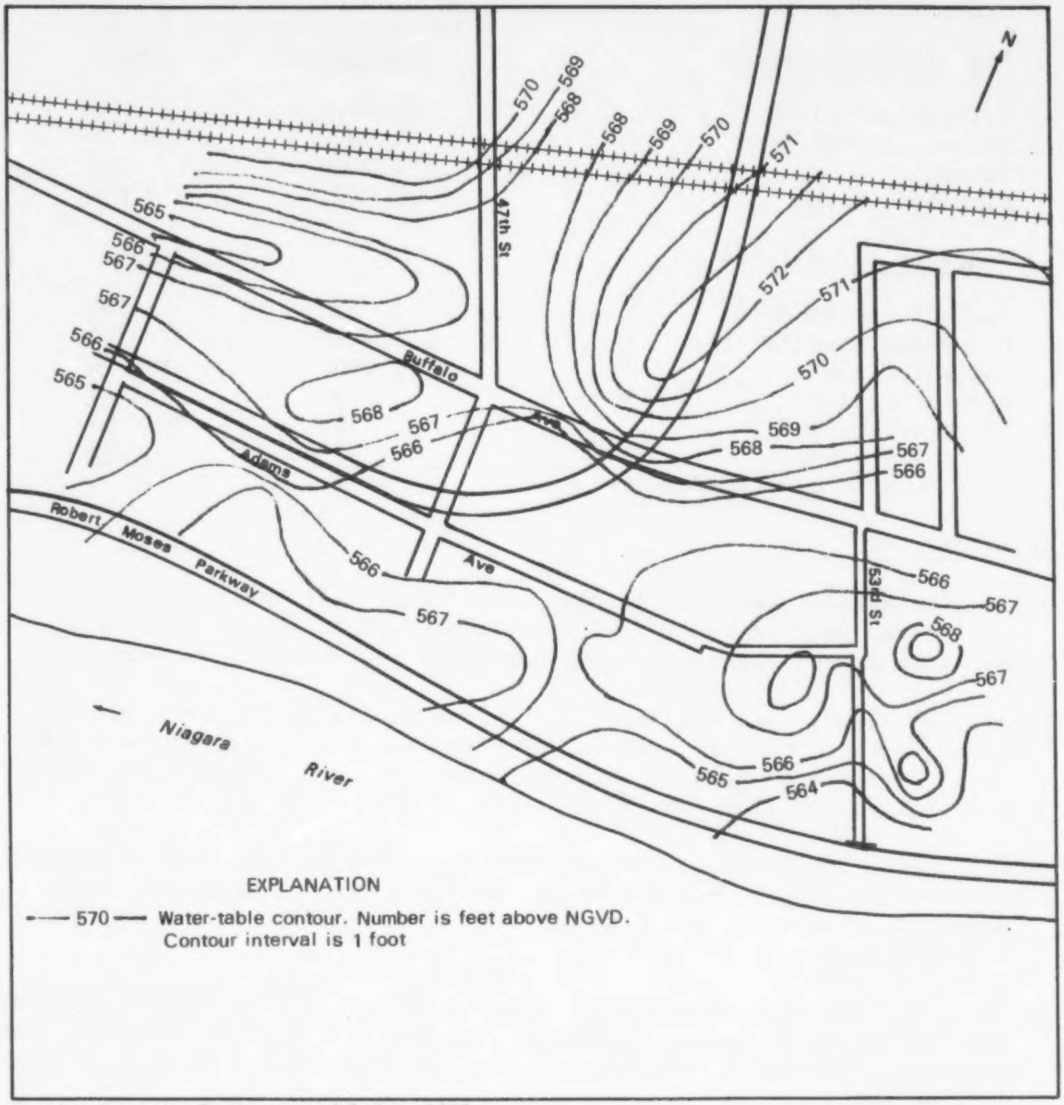
__________1979, Shallow ground-water quality investigation, Hooker Chemicals and Plastic Corporation, Niagara Falls, New York Plant: Westport, Conn., Leggette, Brashears, and Graham, Inc., Progress Report 3, 4 p., 3 figs., 3 appendices.

__________1979, Shallow ground-water quality investigation, Hooker Chemicals and and Plastic Corporation, Niagara Falls, New York Plant: Westport, Conn., Leggette, Brashears, and Graham, Inc., Progress Report 4, 4 p., 4 figs., 3 appendices.

__________1979, Shallow ground-water quality investigation, Hooker Chemicals and Plastic Corp., Niagara Falls, New York Plant: Westport, Conn., Leggette, Brashears, and Graham, Inc., Progress Report 6, 13 p., 20 figs.

__________1979, Shallow ground-water quality investigation, Hooker Chemicals and Plastics Corp., Niagara Falls, New York Plant: Westport, Conn., Leggette, Brashears, and Graham, Inc., Progress Report 7, 12 p.

__________1980, Hooker Chemicals and Plastics Corp., Niagara Falls Plant, New York, geologic logs: Westport, Conn., Leggette, Brashears, and Graham, Inc., 162 p.

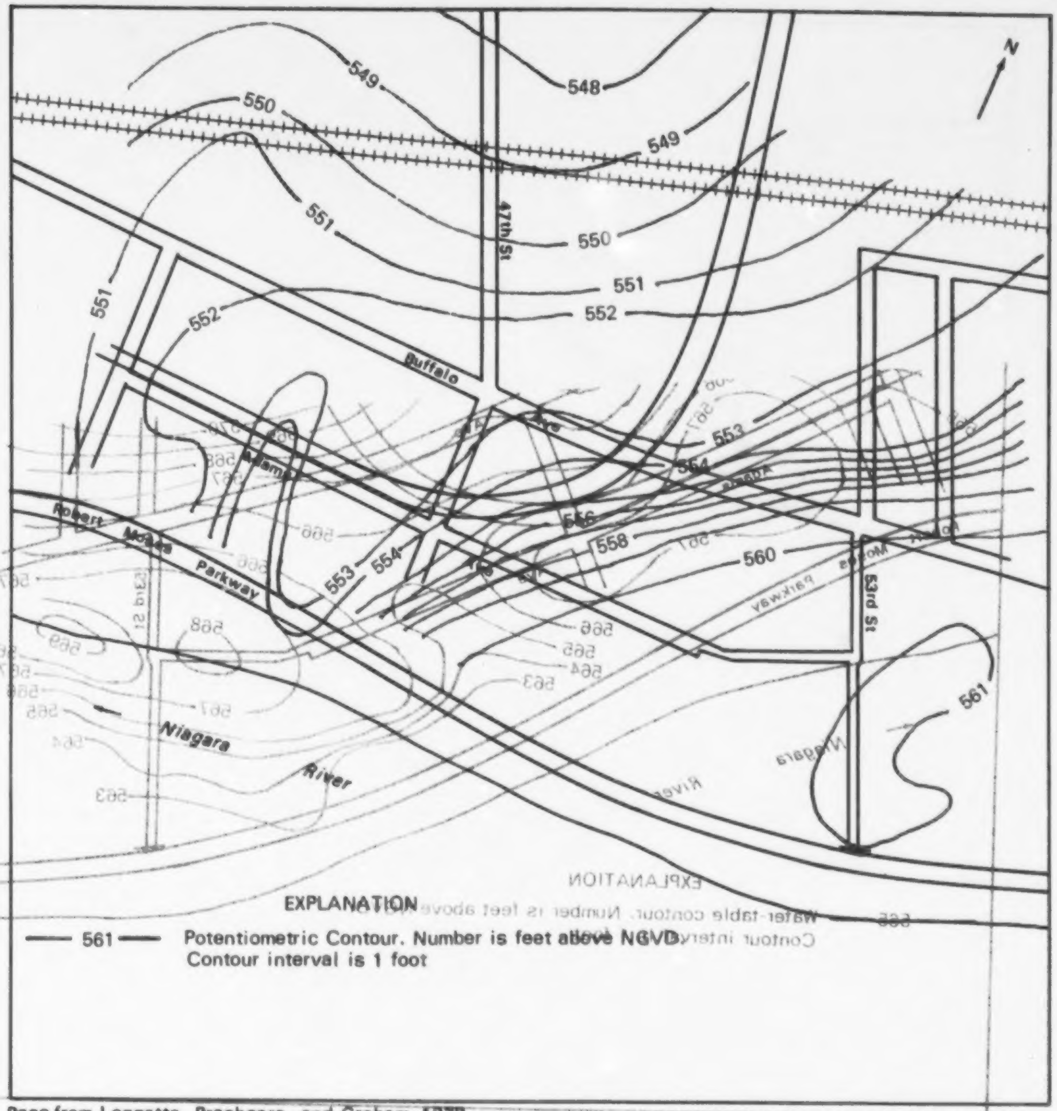


Base from Leggette, Brashears, and Graham, 1979

Figure C-22. Water-table altitudes in overburden aquifer, June 1979, Occidental Chemical--Buffalo Avenue Plant, sites 41b through 49, Niagara Falls.

Base from Leggett

Figure C-28. W s in overburden aquifer, September 1979, Oc l--Buffalo Avenue Plant, sites 41b through 49, gar e.



Base from Leggette, Brashears, and Graham, 1979

Figure C-24. Potentiometric surface of bedrock aquifer, June 1979, Occidental Chemical--Buffalo Avenue Plant, sites 41a through 49, Niagara Falls.

Table C-12.--Results of permeability tests at Occidental Chemical, Buffalo Ave. Plant, sites 41b-49, Niagara Falls, N.Y., January 7-8, 1980.[1]

Well no.	Saturated thickness (ft)	Transmissivity		Permeability		Formation material
		(gal/d)/ft^2	(cm^2/s)	(gal/d)/ft	(cm/s)	
B-5A	5.5	390	5.6×10^{-1}	70.9	3.3×10^{-3}	Fill
B-7A	14.5	195	2.8×10^{-1}	13.4	6.3×10^{-4}	Silty fill
B-8A	19.0	106	1.5×10^{-1}	5.6	2.6×10^{-4}	Silty fill
B-10A	8.0	1	1.5×10^{-3}	0.13	6.1×10^{-6}	Silty fill
B-10A	7.5	63	9.1×10^{-2}	8.4	4.0×10^{-4}	Silty fill
B-13A	20.0	Recovered too quickly for evaluation		200*	9×10^{-3}	Fill
B-14A	7.0	Recovered too quickly for evaluation		200*	9.0×10^{-3}	Fill
B-14B	16.0	2	2.9×10^{-3}	0.13	6.1×10^{-6}	Very fine sand
B-15A	19.0	34	4.9×10^{-2}	1.8	8.5×10^{-5}	Very fine sand
B-16A	6.5	552	7.9×10^{-1}	85	4.0×10^{-3}	Fill
CW-1A	7.0	Recovered too quickly for evaluation		200*	9.0×10^{-3}	Fill
CW-1B	10.0	102	1.5×10^{-1}	10.2	4.8×10^{-4}	Very fine sand
TRW-1A**	5.5	554	7.9×10^{-1}	100	4.7×10^{-3}	Fill

[1] Data from Leggette, Brashears, and Graham, Inc. (1980).
* Arbitrarily assigned value.
** Pumping test run in July 1979.

51. TAM CERAMICS (Literature review) NYSDEC 932028

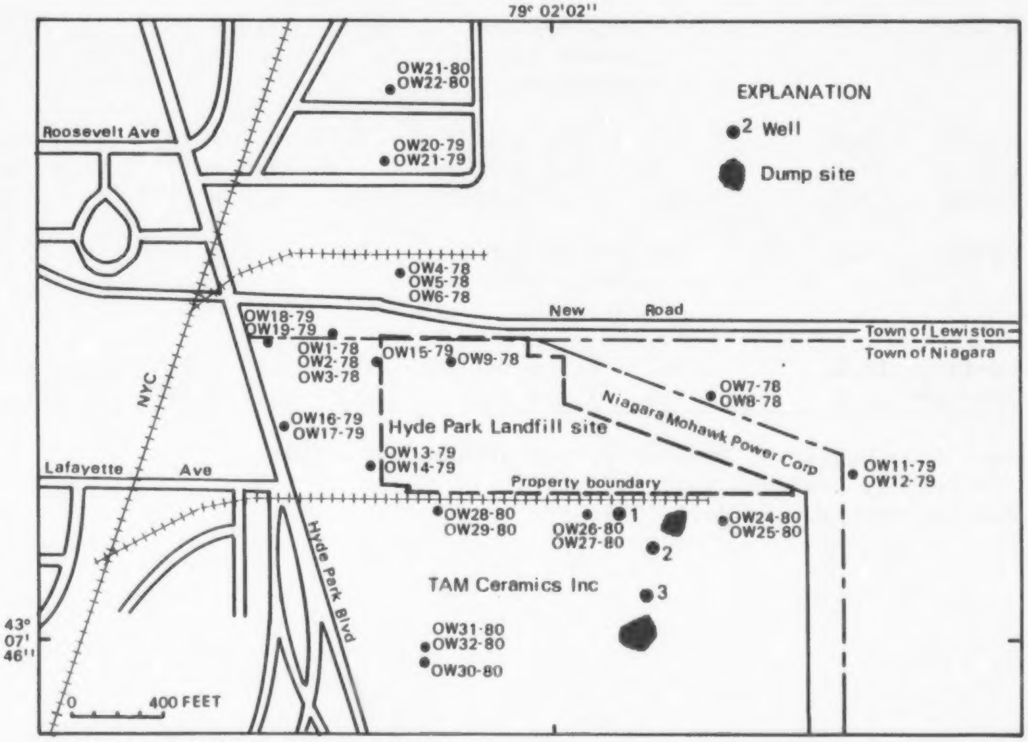
General information and chemical-migration potential.--The TAM Ceramics site, in the northern part of the city of Niagara Falls, contains several small shallow landfills for disposal of obsolete equipment, ceramics, and metallic salts. The site contains 12 monitoring wells (fig. C-25).

Nonaqueous-phase organic compounds have been found in the sewerlines of the TAM property that are attributable to the Hyde Park Landfill (site 39). As a result, several new wells were installed on the TAM property by Occidental

Chemical Corporation as part of the aquifer survey program at the Hyde Park site. Geohydrologic information would be needed to determine the movement of contaminants from this site. The potential for contaminant migration is indeterminable.

Hydrologic information.--Water levels were measured in nine of the monitoring wells. Water levels decrease with well depth and toward the west, which indicates downward and westward movement of ground water. No water-level information is available from wells 1, 2, or 3.

Chemical information.--TAM sampled wells 1, 2, and 3 in June 1979 and analyzed for several metals, pH, 28 priority pollutants, and several other nonpriority organic compounds. Well 1, nearest to the Hyde Park landfill, contained several compounds in significant concentrations; data are available from NYSDEC, Buffalo, N.Y.



Base from Conestoga, Rovers, and Associates, 1980

Figure C-25. Location of monitoring wells at TAM Ceramics, site 51, Niagara Falls.

56. OLIN 102ND STREET LANDFILL (Literature review) NYSDEC 932031

General information and chemical-migration potential.--The Olin landfill, on 102nd Street in the city of Niagara Falls, was used during 1948-70 for disposal of chemical wastes. More than 80,000 tons of waste are buried on the site.

The types and quantities of waste buried at the site during 1948-70 are:

Substance	Quantity (tons)
"Black Cake"	20,000
Graphite	742
Benzene hexachloride and trichlorophenol mixture	60
Trichlorbenzene	150
α- and β-BHC cake	1,200
Tetrachlorobenzene	1,100
Lime sludge	23,900
Brine sludge	20,000
Hexachlorobenzene	60
Trichloroanisole	unknown
Concrete	6,625

This site has a major potential for contaminant migration. A recent report of the site by Recra and Wehran (1979) indicates a plume of contaminanted ground water intruding the alluvial deposits of the Niagara River beneath the landfill and discharging into the Niagara River. Additional data would be needed to determine the rate of contaminant migration and the total amount of contaminants entering the river. The site is currently under litigation for remedial action.

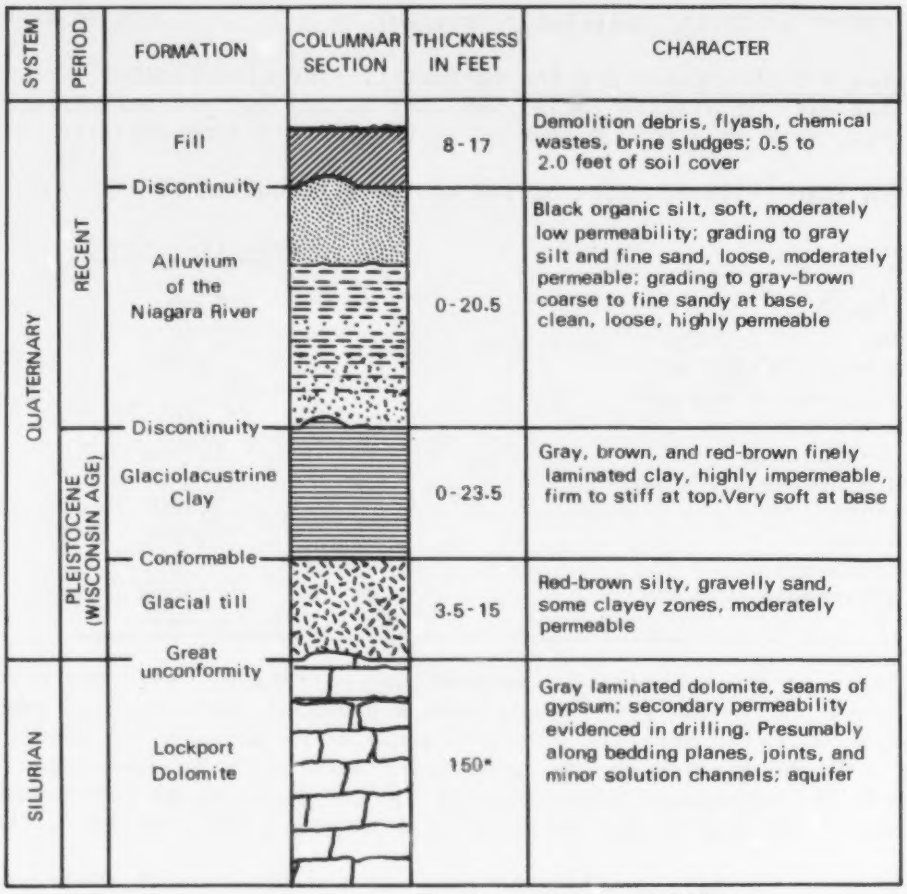
Geologic information.--The site consists of fill and recent alluvial river sediments underlain by Pleistocene lacustrine clay and till. These unconsolidated deposits are underlain by Lockport Dolomite. A generalized geologic column is shown in fig. C-26.

The site owner drilled 21 test borings and monitoring wells on the property. A geologic description of each boring is included in a report by Recra Research Inc., and Wehran Engineering Corporation (1979).

Hydrologic information.--Water levels were measured in the monitoring wells in January 1979. A cross section of the flow pattern and direction of contaminant migrtion is gien in fig. C-27; a ground-water-contour map is given in figure C-28. The contours indicate that ground water flows toward the Niagara River and into adjacent streams and sewerpipes.

Chemical information.--Many water samples from wells and the Niagara River and sediment samples from the river were collected. Results are reported in Recra and Wehran (1979). The analyses indicate elevated concentrations of iron, manganese, sodium, zinc, mercury, chlorides, sulfates, and total halogenated organics within the ground water. Most of the halogenated organics were chlorinated.

Source of data.--Recra Research Inc., and Wehran Engineering Corp., 1979, Hydrogeologic investigation, Olin 102nd Street Landfill, Niagara Falls, Niagara County, New York: 98 p., 1 appendix, 13 figs.



SYSTEM	PERIOD	FORMATION	COLUMNAR SECTION	THICKNESS IN FEET	CHARACTER
QUATERNARY	RECENT	Fill		8-17	Demolition debris, flyash, chemical wastes, brine sludges; 0.5 to 2.0 feet of soil cover
		Discontinuity			
		Alluvium of the Niagara River		0-20.5	Black organic silt, soft, moderately low permeability; grading to gray silt and fine sand, loose, moderately permeable; grading to gray-brown coarse to fine sandy at base, clean, loose, highly permeable
		Discontinuity			
	PLEISTOCENE (WISCONSIN AGE)	Glaciolacustrine Clay		0-23.5	Gray, brown, and red-brown finely laminated clay, highly impermeable, firm to stiff at top.Very soft at base
		Conformable			
		Glacial till		3.5-15	Red-brown silty, gravelly sand, some clayey zones, moderately permeable
		Great unconformity			
SILURIAN		Lockport Dolomite		150*	Gray laminated dolomite, seams of gypsum; secondary permeability evidenced in drilling. Presumably along bedding planes, joints, and minor solution channels; aquifer

* Drilling penetrated upper 15 feet

Figure C-26. Generalized geologic column of formations underlying Olin 102nd Street Landfill, site 56, Niagara Falls.

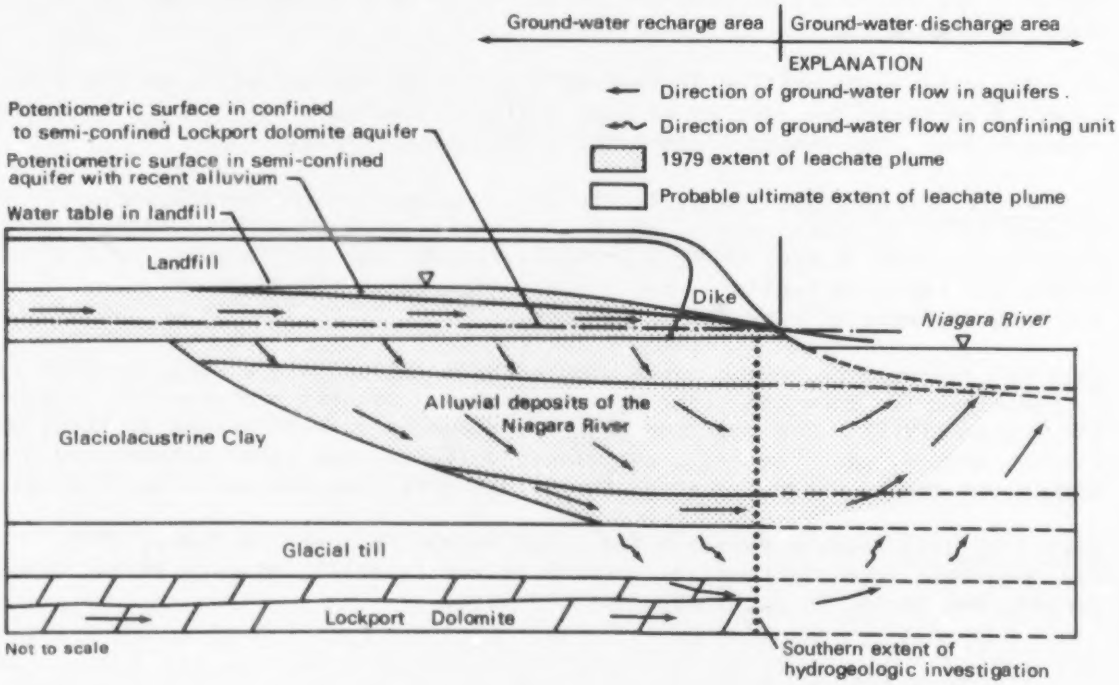
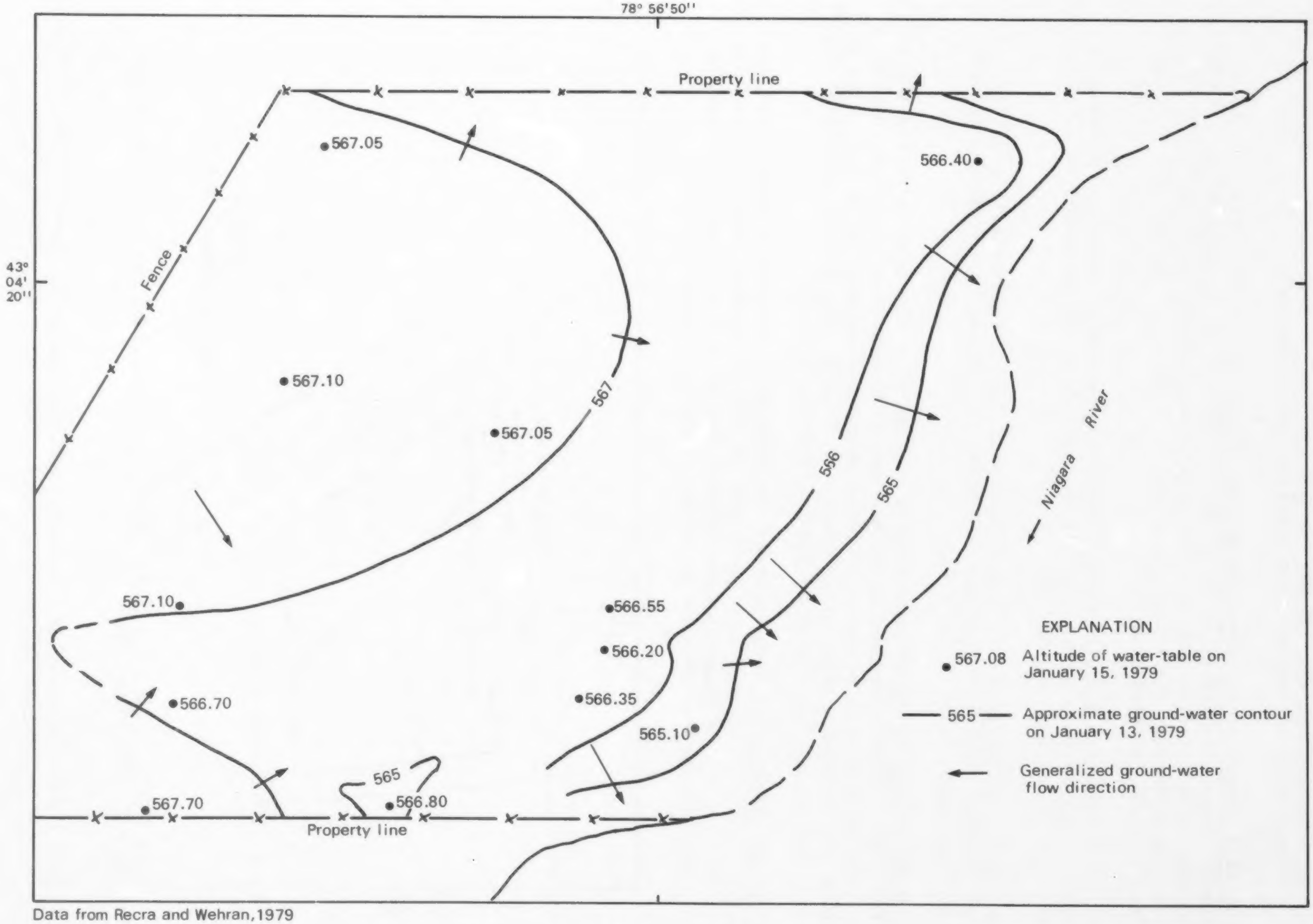

Ground-water recharge area
Ground-water discharge area
EXPLANATION
Direction of ground-water flow in aquifers.
Direction of ground-water flow in confining unit
1979 extent of leachate plume
Probable ultimate extent of leachate plume
Potentiometric surface in confined to semi-confined Lockport dolomite aquifer
Potentiometric surface in semi-confined aquifer with recent alluvium
Water table in landfill
Landfill
Dike
Niagara River
Alluvial deposits of the Niagara River
Glaciolacustrine Clay
Glacial till
Lockport Dolomite
Not to scale
Southern extent of hydrogeologic investigation

Figure C-27. Profile of ground-water flow patterns and contamination plume, Olin 102nd Street Landfill, site 56, Niagara Falls.



Data from Recra and Wehran, 1979

Figure C-28. Water-table altitude at Olin 102nd Street Landfill, site 56, Niagara Falls, January 15, 1979.

57. OLIN INDUSTRIAL WELDING CORPORATION NYSDEC 932050
(Literature review and USGS electromagnetic survey)

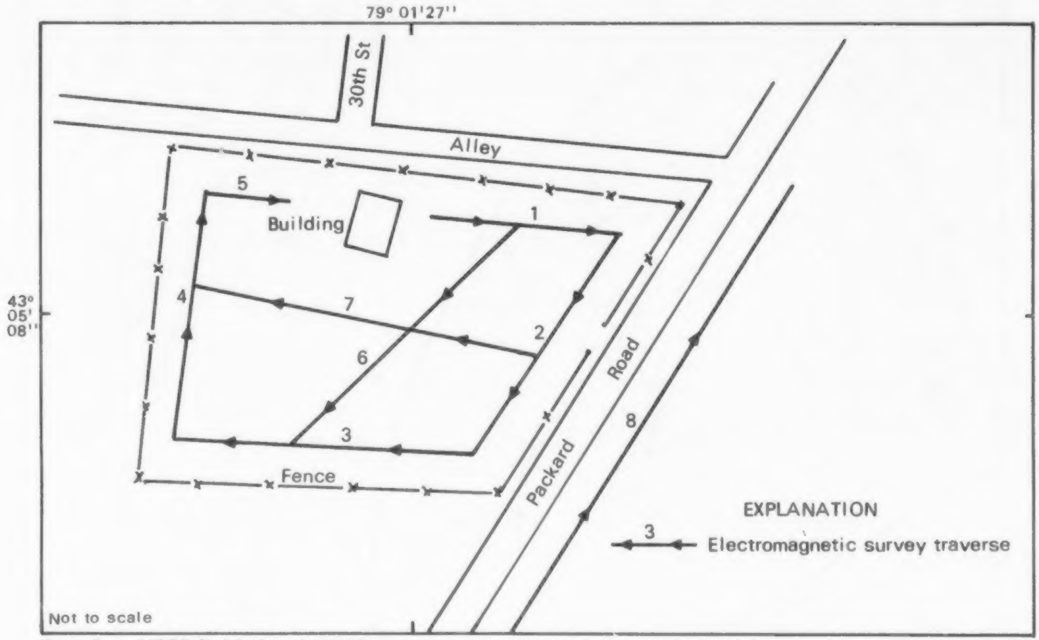
General information and chemical-migration potential.--The Olin Industrial Welding Corporation site, north of Buffalo Avenue in the city of Niagara Falls, was used as a landfill during 1974-60 for the disposal of 403 tons of brine sludge with mercury waste and transformer oil that may contain PCB's and miscellaneous industrial scrap.

The potential for contaminant migration is indeterminable. No samples (soil or water) were taken. Additional testing would be needed to determine the presence of leachate migration.

Geologic information.--The site consists of fill overlying silt and silty clay underlain by bedrock of Lockport Dolomite. Thickness of the unconsolidated deposits ranges from 12 to 17 ft.

Hydrologic information.--Ground water was found in the fill overlying the silt-clay unit; this is probably a perched water-bearing zone that forms during seasons of high precipitation. Ground water also occurs in the silt-clay unit above the bedrock. Regional ground-water flow in this zone is generally southward, but in the bedrock it is generally northwestward.

Chemical information.--No chemical information is available except that the waste material contains mercury (2,200 to 130,000 μg/kg), hexachlorobenzene (20 to 780 μg/kg), and hexachlorocyclohexane (40 to 48,000 μg/kg). The owners estimate the rate of offsite migration of mercury to be 0.2 lb/yr.



Base from USGS field sketch, 1982

Figure C-29. Location of electromagnetic-conductivity survey lines at Olin Industrial Welding Corporation, site 57, Niagara Falls.

Electromagnetic survey.--The U.S. Geological Survey conducted an electromagnetic survey with eight lines in 1982. Locations are shown in fig. C-29; the data are plotted in fig. C-30.

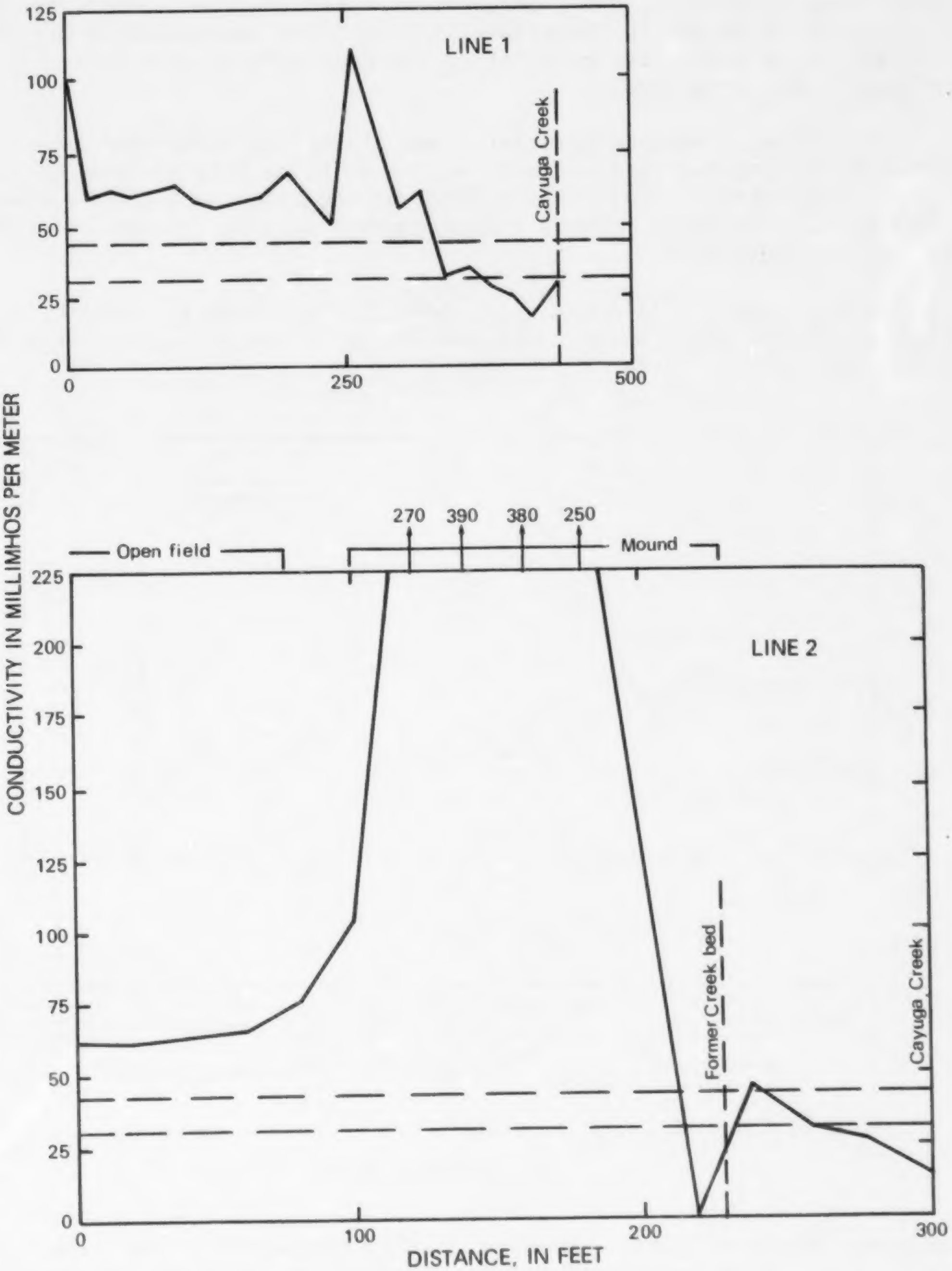


Figure C-30. Results of electromagnetic-conductivity survey at Olin Industrial Welding Corporation, site 57, Niagara Falls, lines 1 and 2.

All conductivity lines but no. 8 were within a fenced area adjacent to Packard Road, and all show unnatural variations from beginning to end. The extremely high values at the beginning of line 4 seem to be related to the nearby concrete foundations. Steel reinforcing rods in the concrete foundations along lines 3, 4, and 7 strongly affected the conductivity readings. The extremely high values in the middle of line 2 are not explained but may indicate locally buried conductive material or the edge effects of a buried conductor not evident from the surface.

The areas in which conductivity was closest to background level are line 5 (west of the parking lot) and most of the southern half of line 6. Line 5 shows stable conductivity values in the 20-25 mmho/m range, and line 6 shows values in the 45-50 μmho/m range. These values suggest locally homogeneous fill of relatively low conductivity.

Line 8, along Gill Creek, indicates that the bank is composed of or covered with artificial fill, which would mask any evidence of a conductive plume emanating from the site.

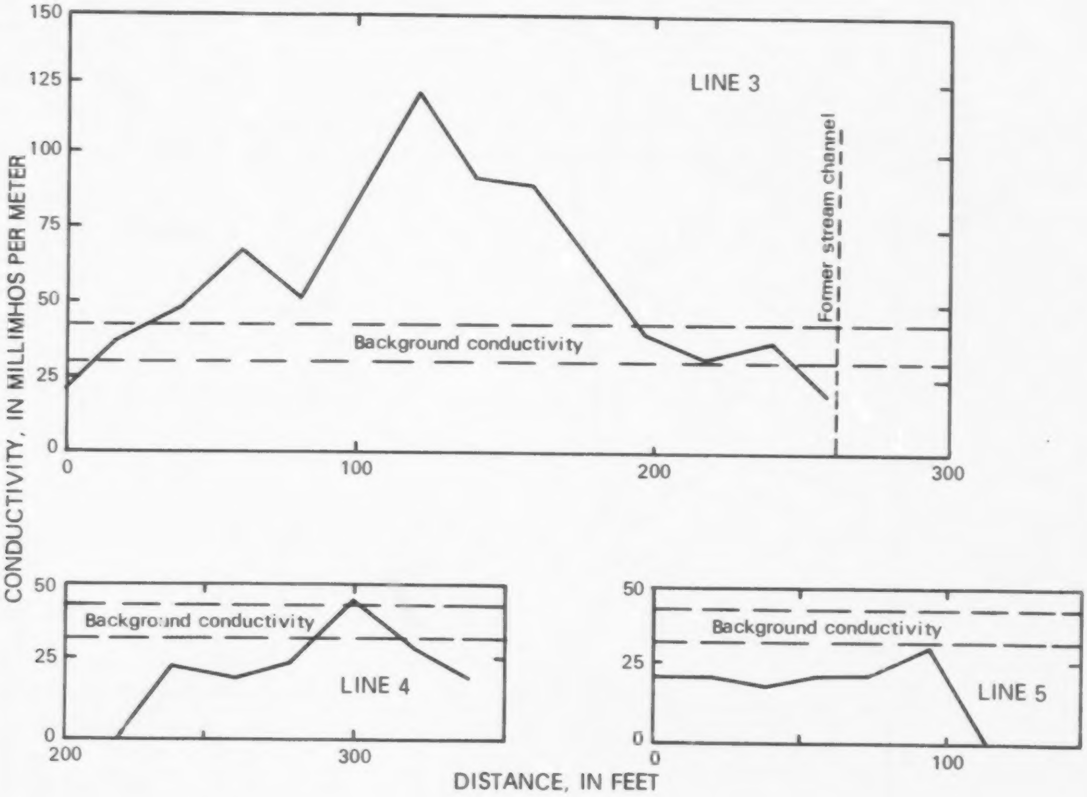


Figure C-30 (continued). Results of electromagnetic-conductivity survey at Olin Industrial Welding Corporation, site 57, Niagara Falls, lines 3 through 5.

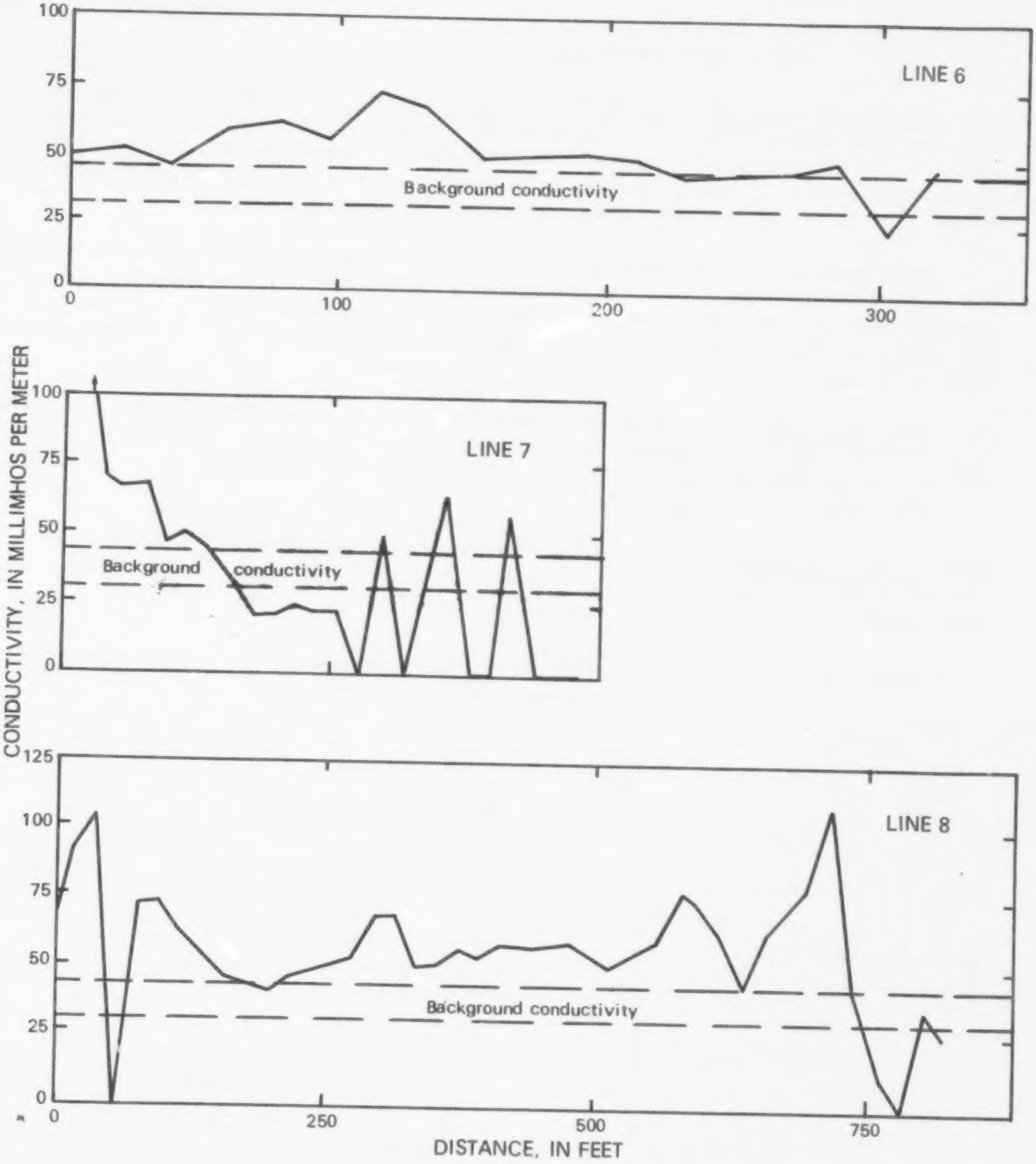


Figure C-30 (continued). Results of electromagnetic-conductivity survey at Olin Industrial Welding Corporation, site 57, Niagara Falls, lines 6 through 8.

58, 59, 248. OLIN, BUFFALO AVENUE (USGS field reconnaissance)

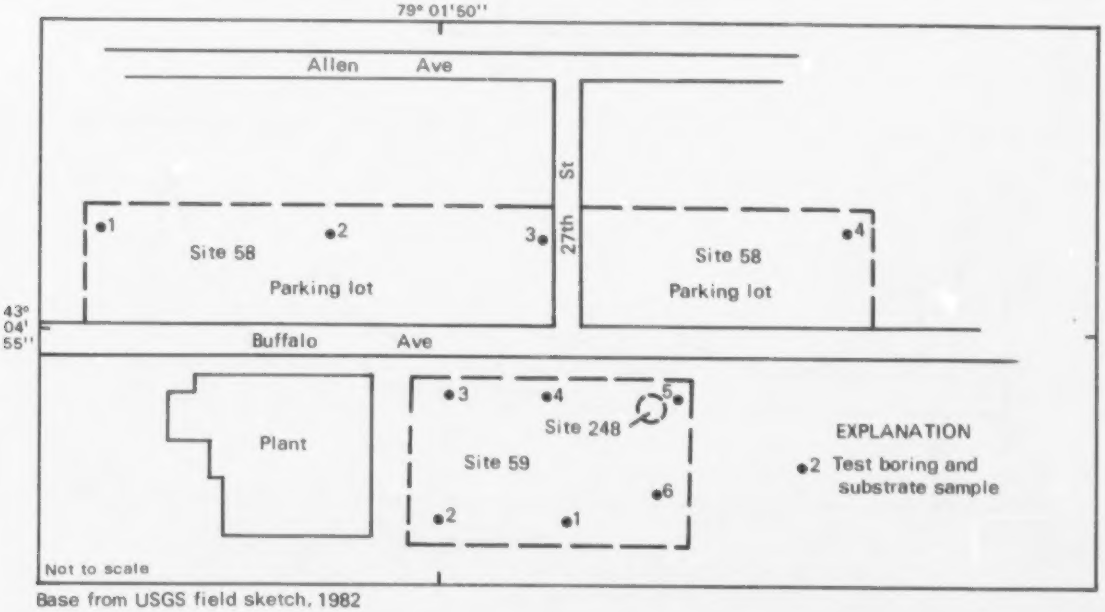
NYSDEC 932051-a, b, 932038

General information and chemical-migration potential.--These three sites, at the Olin Buffalo Avenue plant in the city of Niagara Falls, were used for land-spreading of brine sludge containing mercury and possibly polychlorinated biphenyls. Also on the property is a pond that was used to collect overflow water from site 248, which contains traces of mercury.

Chemical data, proximity to the Niagara River, and the shallow overburden indicate a major potential for contaminant migration. Some samples indicated mercury concentrations to be above background levels. Additional sampling would be needed to determine whether the contaminant is migrating into the ground-water system.

Geologic information.--The sites consists of fill and debris underlain by a sandy clay. The U.S. Geological Survey drilled four test borings on site 58 and six along the perimeter of sites 59 and 248 in 1982 (fig. C-31). The geologic logs are on page 347.

Hydrologic information.--No ground water was encountered. If ground water were in the unconsolidated deposits, the direction of flow would probably be southward toward the river.



Base from USGS field sketch, 1982

Figure C-31. Location of monitoring wells at Olin Buffalo Avenue, sites 58, 59, and 248, Niagara Falls.

Boring no.	Depth (ft)	Description
		Site 58
1	0 - 3.0	Topsoil.
	3.0 - 3.5	Clay, sandy, yellowish, damp.
	3.5 - 8.0	Clay, reddish, gravel, sandy. Bedrock at 8.0 ft.
		SAMPLE: 3 ft.
2	0 - 2	Black topsoil
	2 - 4.5	Clay, sandy, gravel, yellowish. Bedrock at 4.8 ft.
		SAMPLE: 4 ft.
3	0 - 3.0	Topsoil, brown to black at 2.0 ft.
	3.0 - 3.5	Clay, red.
		SAMPLE: 3 ft.
4	0 - 1.5	Topsoil and gravel.
	1.5 - 2.5	Sand soil, black.
		SAMPLE: 2.5 ft.
		Sites 59 and 248
1	0 - 3.5	Soil, sand, gravel fill.
	3.5 - 5.5	Clay, sandy, tan, damp.
		SAMPLE: 3.5 ft.
2	0 - 3.0	Gravel fill.
	3.0 - 6.5	Sandy clay.
		SAMPLE: 4 ft.
3	0 - 1.0	Topsoil, brown.
	1.0 - 4.0	Clay, sandy.
		SAMPLE: 2 ft.
4	0 - 2	Fill, debris, bricks.
		SAMPLE: 2 ft.
5	0 - 3.0	Topsoil, debris.
		SAMPLE: 2.5 ft.
6	0 - 1	Topsoil, debris.
		SAMPLE: 1 ft.

Chemical information.--Olin installed 10 monitoring wells in the eastern area of the plant site adjacent to Gill Creek in 1980. Sampling during 1980-82 indicates the following concentrations at the downgradient well, which was drilled to the top of bedrock in the southeastern area of the plant:

Olin Plant Site - Downgradient Well

	Concentration (µg/L)	
Priority pollutants	Maximum	Mean
Mercury	21.5	13.5
2-Chlorophenol	170	56
2,3 and 2,4 and 2,5 Dichlorophenol	83	33
Pentachlorophenol	50	23
γ-BHC (Lindane)	4,200	1,248
Nonpriority pollutants		
Total halogenated organics	14,000	4,087
Total volatile halogenated organics	9,400	4,287
3-Chlorophenol & 4-Chlorophenol	98	47
2,4,5 and 2,3,4 Trichlorophenol	140	49
2,3,4,6 Tetrachlorophenol	50	23

The U.S. Geological Survey collected soil samples from each test boring for iron and mercury analysis. Each sample was split with the site owner. Results of the U.S. Geological Survey analyses are shown in table C-13. Mercury concentration in sample 6 of the pond borings exceeded concentrations from undisturbed soils in the area. The samples contained eight organic priority pollutants, of which only benzene (48,000 µg/kg) exceeded the quantifiable detection limit, and two organic nonpriority pollutants.

Results of the site owner's analyses are shown in table C-14, which indicates high concentrations of mercury in samples 3 and 4 from the parking lot and samples 2, 4, 5, and 6 of the pond borings. Relative concentrations of organic compounds between samples are indeterminable because the quantifiable detection limits are unknown.

Table C-13.--U.S. Geological Survey analyses of substrate samples from Olin parking lot and Olin mercury ponds, sites 58, 59, and 248, Niagara Falls, N.Y., August 9, 1982.
[Locations shown in fig. C-31. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

PARKING LOT	Sample number and depth below land surface (ft)				
	1 (3.5)	(Split)	2 (4.0)	3 (3.0)	4 (2.5)
Inorganic constituents					
Iron	1,300,000	(7,100,000)	830,000	2,800,000	1,800,000
Mercury	—	(--)	—	330††	10
Organic compounds	***	***	***	***	***
Nonpriority pollutant					
Hexamethylcyclotrisiloxane[1]	—	(--)	3,000	3,200	—

MERCURY PONDS	Sample number and depth below land surface (ft)					
	1 (3.5)	2 (4.0)	3 (2.0)	4 (2.0)	5 (2.5)	6 (2.0)
Inorganic constituents						
Iron	2,600,000	1,800,000	1,000,000	1,900,000	940,000	1,400,000
Mercury	40	80	—	14	60	220††
Organic compounds	***	***	***	***	***	***
Priority pollutants		LT				
Phenanthrene	--	LT	--	--	--	--
Fluoranthene	--	LT	--	--	--	--
Pyrene	--	LT	--	--	--	--
Benzoanthracene	--	LT	--	--	--	--
Chrysene	--	LT	--	--	--	--
Benzo(a)pyrene	--	LT	--	--	--	--
Benzo(b)fluoranthene	--	LT	--	--	--	--
Benzo(k)fluoranthene	--	LT	--	--	--	--
Benzene	--		48,000	--	--	--
Nonpriority pollutants						
3-Hexen-2-one[1]	5,100	--	--	--	--	--
Hexamethylcyclotrisiloxane[1]	2,700	--	--	--	--	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. The concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from undisturbed soils in the Niagara Falls area. Undisturbed soils not analyzed for iron.

*** Samples analyzed at detection limit above that required by this study.

Table C-14.--Site owner's analyses of substrate split samples from Olin parking lot and Olin mercury ponds, sites 58, 59, and 248, Niagara Falls, N.Y., August 9, 1982.
[Locations shown in fig. C-31. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found. Data from Olin Incorporated, 1982.]

PARKING LOT	Sample number and depth below land surface (ft)			
	1 (3.5)	2 (4.0)	3 (3.0)	4 (2.5)
Inorganic constituents				
Cyanide, total	--	--	1,400	4,800
Mercury, total	170	300	4,500††	20,000††
Mercury extract	<500	<500	<500	<500
Organic compounds				
Polycyclic aromatic hydrocarbons (PAH)	--	<<6,000	<<10,000	<<12,000
Chlorobenzenes	--	--	<<4,000	<<12,000
Hexachlorobutadiene	--	--	<2,000	--
Chlorinated methanes and ethanes	<10	<52	<580	<50
Other volatiles	<10	<20	<138	<30
Pesticides, Non-BHC	--	--	<55	--
Pesticides, BHC	--	<41	<45	<137

MERCURY PONDS	Sample number and depth below land surface (ft)					
	1 (3.5)	2 (4.0)	3 (2.0)	4 (2.0)	5 (2.5)	6 (2.0)
Inorganic constituents						
Cyanide, total	2,000	1,200	--	--	--	--
Mercury, total	17,000†	6,700††	<80	40,000†	5,900†	2,800††
Mercury extract	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Organic compounds						
Polycyclic aromatic hydrocarbons	<<<27,200	<<<37,300	--	<<<44,300	--	<<<22,000
Chlorobenzenes	<<4,000	<2,000	--	<4,000	--	<2,000
Hexachlorobutadiene	<2,000	--	--	--	--	<2,000
Chlorinated methanes and ethanes	<<<59	<<140	11	<229	<10	<<52
Other volatiles	<66	<21	--	<420	--	<10
Pesticides, Non-BHC	40	40	--	--	--	--
Pesticides, BHC	92	<20	--	<125	--	106

†† Exceeds concentrations in samples taken from undisturbed soils in the Niagara Falls area.

62. STAUFFER CHEMICAL, NORTH LOVE CANAL (Literature review) NYSDEC 932034

General information and chemical-migration potential.--The Stauffer Chemical, North Love Canal site, in the town of Lewiston, was used by Stauffer during 1930-52 to bury approximately 50,000 yd^3 of waste asbestos, cell parts, reactor linings, scrap sulfur, other metallic industrial wastes, and possibly flux. The site was then covered, and a housing development has been built over it.

Previous studies indicate the potential for contaminant migration to be limited, but the potential is indeterminable from the limited data. Some chemical constituents have been detected at high concentrations in offsite soil and water samples. Periodic sampling would be needed to confirm the migration of leachate, however.

Geologic information.--The site consists of a few inches of organic topsoil overlying a reddish-brown clayey silt or till, ranging in thickness from 1.5 ft to 17 ft (Dominion Soil Investigations, Inc., 1979). The underlying bedrock is Lockport Dolomite.

Hydrologic information.--Ground water was encountered in the lower part of the till unit. The direction of ground-water flow is northward. Ground-water flow in the underlying bedrock is also probably northward toward the Niagara Escarpment.

Chemical information.--Chemical data on soil and water samples are summarized in a report by Dominion Soil Investigations, Inc. (1979). Results indicate high concentrations of fluoride, magnesium, nitrate, and sulfate within the site.

Sources of data

Dominion Soil Investigations, Inc., 1979, Report of Lewiston Escarpment Project, analysis of subsoil conditions, Whittaker Subdivision, Lewiston, New York: Dominion Soil Investigations, Inc., 18 p., 2 tables, 1 enclosure.

Moriarty, L. R., 1979, Report on Love Canal Section, Lewiston, New York: U.S. Environmental Protection Agency, Rochester Program Support Branch, 8 p., 1 addendum.

63. STAUFFER CHEMICAL--ART PARK SITE NYSDEC 932049
(USGS field reconnaissance)

General information and chemical-migration potential.--The Stauffer Chemical--Art Park site, in Lewiston, was used for the disposal of unknown quantities of asbestos, graphite, cinders, reactor linings, scrap sulfur and metal, and silicon, zirconium, and titanium oxides. Most of the waste had been covered by 1979, and the site is now a park.

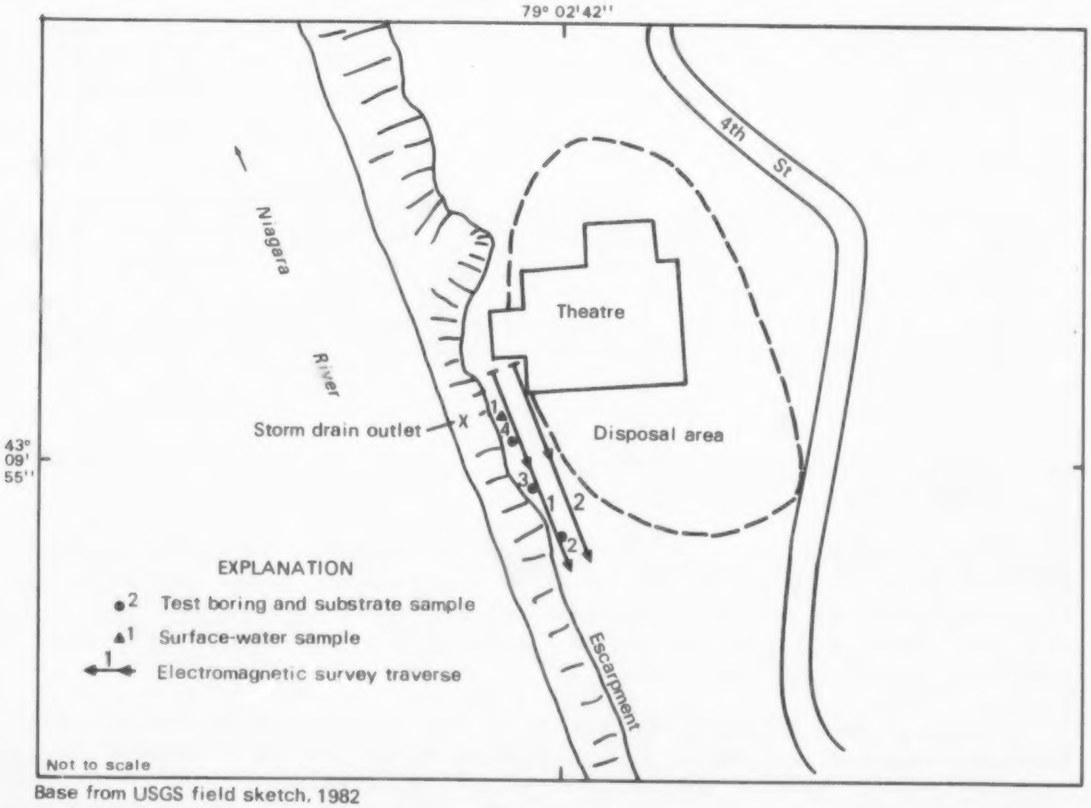
Chemical data indicate the potential for contaminant migration to be limited. However, proximity to the Niagara River and the closeness of fractured bedrock to land surface suggest that migration could occur, but additional data would be needed to substantiate this. The potential for contaminant migration is indeterminable.

Geologic information.--The site consists of a thin mantle of till underlain by dolomitic limestone. The U.S. Geological Survey drilled three test borings in 1982 by hand auger to bedrock, which was encountered within 3 ft. The bedrock appeared to be shale; the overburden consists of topsoil and clean fill. Locations of the borings are shown in fig. C-32.

Hydrologic information.--No ground water was encountered during the test drilling; ground water is probably restricted to fractures within the shale. The direction of ground-water flow is westward toward the river.

Chemical information.--The U.S. Geological Survey collected three soil samples and one surface-water sample for organic-compound analyses; no organic compounds were detected.

Electromagnetic survey.--The U.S. Geological Survey made an electromagnetic survey at the site in 1982. The steep topography west of the site allowed only two practical locations for conductivity lines; these are shown in fig. C-32; the data are plotted in fig. C-33. Line 1 was along the bank of the Niagara River; line 2 was along a path parallel to, but much higher than, line 1. The first 300 ft of line 1 show mostly background values, but at least two buried objects are indicated. Less irregularly spaced buried materials are indicated between 300 and 700 ft, but the fluctuations remain within a general trend of elevated values. Beyond 700 ft, a gradual decline in conductivity is indicated, which



Base from USGS field sketch, 1982

Figure C-32. Location of sampling holes and electromagnetic-conductivity survey lines at Stauffer Chemical--Art Park Site, site 63, Lewiston.

may reflect a local contact between shale and dolomite. This decrease is clearly visible in line 2. The elevated values at the beginning of line 2 are caused by a local drainage pipe.

Although most of line 2 is above the background conductivity range typical for Erie and Niagara Counties. It probably indicates natural conditions because background conductivity would be elevated in saturated shale outcrops such as that traversed by line 2.

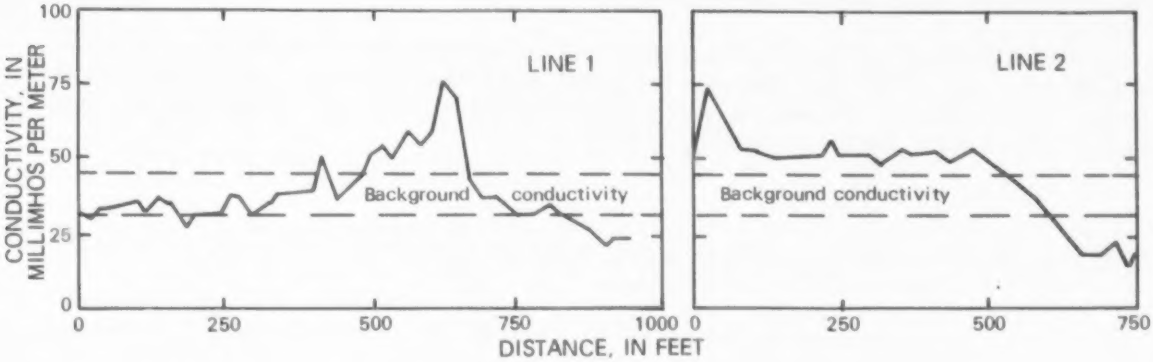


Figure C-33. Results of electromagnetic-conductivity survey at Stauffer Chemical--Art Park Site, site 63, Lewiston.

64. UNION CARBIDE (USGS field reconnaissance) NYSDEC 932035

General information and chemical-migration potential.--The Union Carbide site, an active landfill in the city of Niagara Falls, was used to dispose of carbonaceous material, wood scraps, and firebrick at an estimated rate of 8.5 million lb/yr.

The potential for contaminant migration is indeterminable. The geologic character of the site indicates that a layer of lacustrine clay would impede vertical migration. The chemical analyses indicate no contamination offsite.

Geologic information.--The owners installed two monitoring wells on the site. The geologic logs are as follows:

Well no.	Depth (ft)	Description
1 (north)	0 - 12.5	Carbonaceous fill.
	12.5 - 19.0	Till.
	19.0	Lockport Dolomite
2 (south)	0 - 4.0	Carbonaceous fill.
	4.0 - 15.0	Lacustrine clay.
	15.0 - 19.8	Till.
	19.8	Lockport Dolomite.

Hydrologic information.--Although no water-level data from the monitoring wells are available, a regional seasonal water table forms above the lacustrine clay during periods of high precipitation. Ground-water flow in the unconsolidated deposits is probably southward toward the river.

Chemical information.--The site owner has sampled both monitoring wells for selected heavy metals and organic compounds semiannually since 1978 and reports the results to the New York State Department of Environmental Conservation; the data are available at the Department's regional office in Buffalo, N.Y.

The U.S. Geological Survey collected water samples from both monitoring wells in August 1982 for organic-compound analysis; results are shown in table C-15. Only dibutyl phthalate was found in well 2, and the concentration was below the quantifiable detection limit.

Table C-15.--Analyses of ground-water samples from Union Carbide, site 64, Niagara Falls, N.Y., August 29, 1982.
[Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)	
	1 (20.8)	2 (15.2)
pH	8.3	7.2
Specific conductance (µmho/cm)	1,570	780
Temperature (°C)	11.0	13.5
Organic compounds		
Priority pollutant		
Dibutyl phthalate	--	LT

66. REICHHOLD-VARCUM CHEMICAL DIVISION (Literature review) NYSDEC 932040

General information and chemical-migration potential.--The Reichhold-Varcum Chemical Division site, on Packard Road in the city of Niagara Falls, had a settling pond for phenolic waste sludges. The pond was evacuated in 1979, and all materials were transported to a secure landfill.

Recent chemical data suggest a major potential for contaminant migration.

Geologic information.--The site consists of a thin unit of silty clay overlying bedrock of Lockport Dolomite. The depth to bedrock ranges from 6 to 8 ft. MacMullin Associates, Inc. drilled three test borings. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 0.2	Asphalt surface.
	0.2 - 0.8	Brown and black loamy sand with gravel.
	0.8 - 2.5	Black loamy silt with some gravel.
	2.5 - 6.0	Reddish-brown, silty clay. Some vertical desiccation cracks.
	6.0 - 8.0	Brown clayey-silt.
	8.0	Refusal--bedrock?
2	0 - 0.2	Asphalt surface.
	0.2 - 1.0	Sand and gravel backfill.
	1.0 - 3.0	Blacktop or fill.
	3.0 - 4.0	Brown and black clayey sand.
	4.0 - 5.2	Black gravelly sand.
	5.2 - 6.1	Brown silty clay.
	6.1	Refusal--bedrock?
3	0 - 1.0	Black and brown gravelly fill.
	1.0 - 2.0	Black silty clay.
	2.0 - 6.3	Brown, silty clay with some desiccation cracks.
	6.3 - 7.7	Brown gravelly sand.
	7.7 - 9.5	Gray loamy sand.
	9.5 - 9.9	Brownish-gray, gravelly loam.
	9.9	Refusal--bedrock?

Hydrologic information.--The owner installed three monitoring wells; locations are shown in fig. C-34. Water levels indicate the direction of ground-water flow to be southward. No hydrologic data on the underlying bedrock are available.

Chemical information.--The site owner has collected water samples from the monitoring wells; results are given in table C-16. Recent sampling of additional monitoring wells by the property owner indicates that the unconsolidated material contains phenols in concentrations ranging from 68,000 to 2,700,000 μg/L.

Source of data.--R. B. MacMullin Associates and Auer, C., 1979, Engineering report for the elimination and replacement of the Varcum settling lagoon, Varcum Chemical Division, Reichhold Chemicals, Inc., Niagara Falls, New York: R. B. MacMullin Associates, 8 p., 6 drawings, 2 addendums.

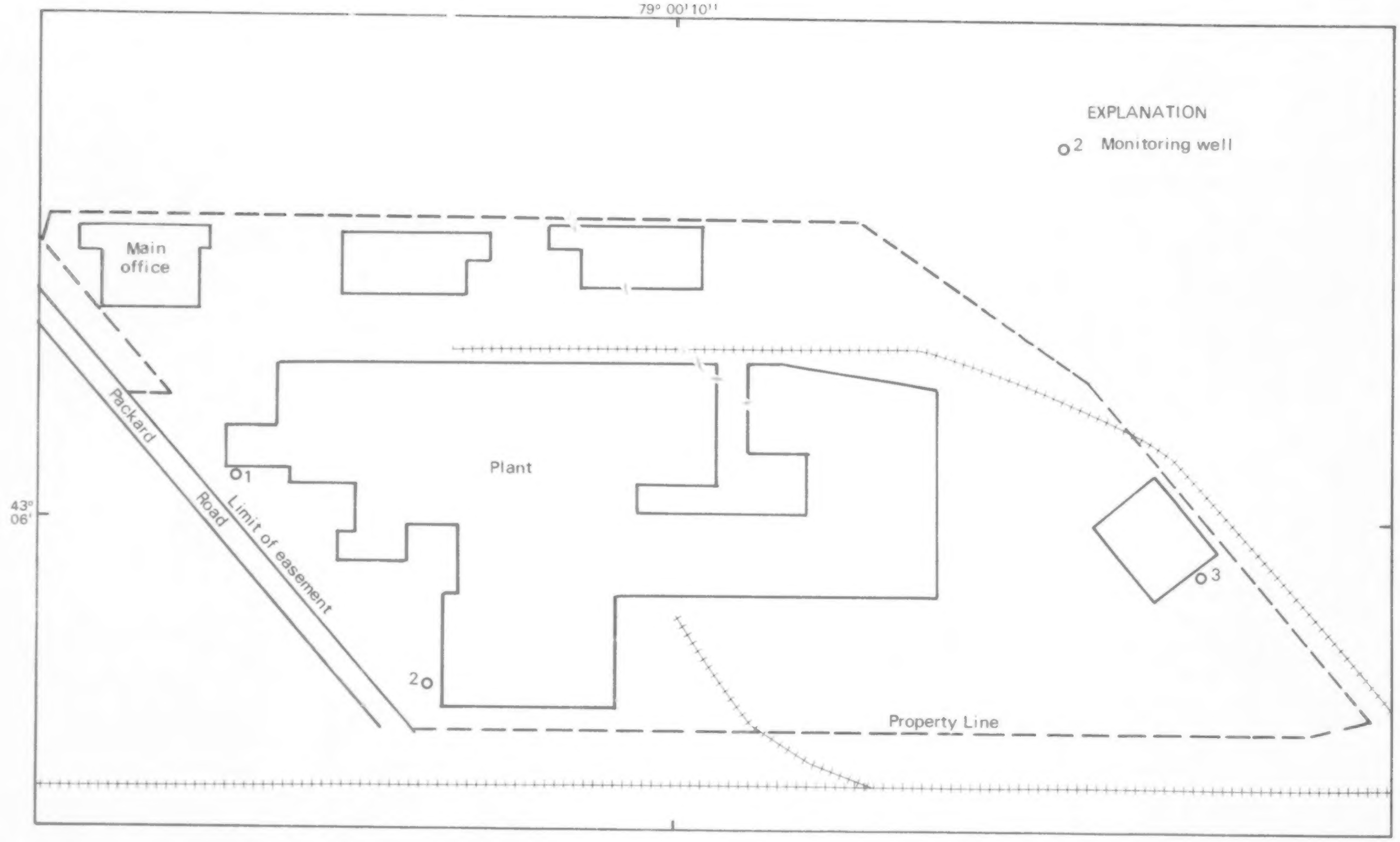


Figure C-34. Location of monitoring wells at Reichhold-Varcum Chemical Division, site 66, Niagara Falls. (Modified from R. B. MacMullin Assoc., 1979.)

Table C-16.--Analyses of ground water from Reichold Varcum Chemical Division, site 66, Niagara Falls, N.Y., June-July 1982[1]

[Locations are shown in fig. C-34. Concentrations are in µg/L.]

Date	Well No.	Phenol
---	1	3,000
	2	50,000
	3	4,000
6/11/82	1	25,000
	2	210,000
	3	15,000
6/23/82	1	60,000
	2	166,000
	3	30,000
6/30/82	1	30,000
	2	126,000
	3	15,000
7/8/82	1	20,000
	2	162,000
	3	20,000

[1] Data collected by Reichold Varcum Chemicals, Inc., Niagara Falls, N.Y.

73. LA SALLE EXPRESSWAY NYSDEC 932067

General information and chemical-migration potential.--LaSalle Expressway is in the city of Niagara Falls. During the construction of the expressway, approximately 20,000 tons of vulcanized fiber and fiber sheeting, thermosetting plastics, and trimmings were deposited as fill. These materials are considered nonhazardous. No geologic, hydrologic, or chemical information are available. The potential of contaminant migration is indeterminable.

76. LYNCH PARK (USGS field reconnaissance) NYSDEC 932006

General information and chemical-migration potential.--Lynch Park, in the town of Wheatfield, was used to deposit clean fill from a sewer project and assorted rubble from an abrasives plant.

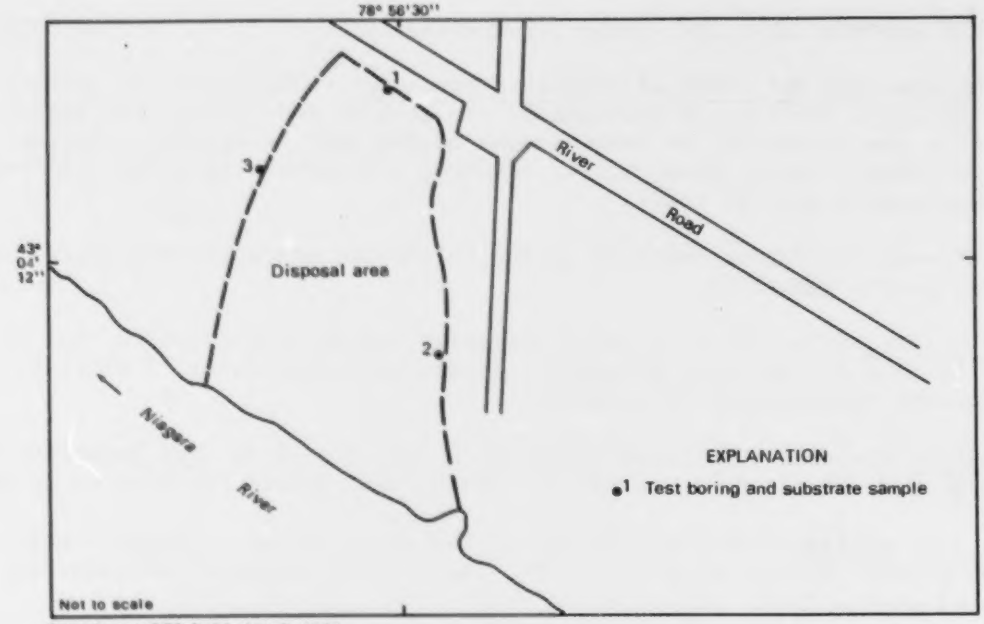
Geologic data indicate some potential for contaminant migration offsite, but the actual potential is indeterminable. One substrate sample contained a high concentration of copper. Additional sampling and monitoring would be needed to evaluate the extent of migration.

Geologic information.--The site consists of fill overlying lacustrine clay deposits containing sand stringers. The U.S. Geological Survey drilled three test holes on the site in 1982; the locations are shown in fig. C-35. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 2.9	Brown topsoil.
	2.9 - 4.6	Clay, greenish-gray with rust stains.
	4.6 - 6.3	Clay, green-gray.
	6.3 - 8.0	Sand, fine to coarse, wet. Clay, pinkish.
		SOIL SAMPLE: 6.5 ft.
2	0 - 3.4	Topsoil, dark brown, clay, gray.
	3.4 - 5.0	Reddish fill.
	5.0 - 6.6	Clayey, black, oily, sandier lower 8 inches.
	6.6 - 8.1	Clay, tan, tight.
	8.1 -11.8	Black organic debris.
	11.8 -13.3	Sand, black-gray, fine to very fine, wet.
		SOIL SAMPLE: 12 ft.
3	0 - 2.0	Topsoil.
	2.0 - 3.5	Debris, fill material, clay, gray, tight, dry.
	3.5 - 5.0	Black carbonlike material.
	5.0 - 6.6	Black organic material.
	6.6 - 8.7	Black, oily, sandy material.
	8.7 - 10.2	Clay, black, sandy, wet.
	10.3 - 11.8	Sand, fine to medium, black, saturated.
		SOIL SAMPLE: 11 ft.

Hydrologic information.--Ground water was encountered in each test boring at 6 to 11 ft below land surface. That saturated material was mainly fine-grained sand but did not produce sufficient water to warrant the installation of monitoring wells. Ground-water flow is southwestward toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected three soil samples for copper, iron, mercury, and organic-compound analyses; results are given in table C-17. Copper was above background levels in sample 2. Only two organic nonpriority pollutants were detected.



Base from USGS field sketch, 1982

Figure C-35. Location of sampling holes at Lynch Park, site 76, Wheatfield.

Table C-17.--Analyses of substrate samples from Lynch Park, site 76, Wheatfield, N.Y., June 19, 1982.
(Locations shown in fig. C-34. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found.]

	Sample number and depth below land surface (ft)		
	1 (6.5)	2 (6.5)	3 (12.6)
Inorganic constituents			
Copper	5,000	61,000††	13,000
Iron	2,300,000	20,000,000	7,400,000
Mercury	--	--	--
Organic compounds			
Nonpriority pollutants			
3,5-Dimethyl-2-pyroxoline-1-carboxamide[1]	--	15,700	--
4,4,5-Trimethyl-2-hexene[1]	--	512	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

†† Exceeds concentrations in samples taken from Niagara Falls area. Undisturbed soils not analyzed for iron.

77. MODERN DISPOSAL SERVICES (USGS reconnaissance) NYSDEC 932025

General information and chemical-migration potential.--The Modern Disposal Services site, in the town of Lewiston in the area of Model City, has been a landfill for the deposition of nonhazardous wastes such as graphite, silica dust, wood, paper, metal scrap, brick, cinders, and industrial waste. It has accepted approximately 150 ton/d.

Additional monitoring would be needed to confirm migration potential. The potential is indeterminable.

Geologic information.--The site owner installed two monitoring wells, but no logs are available. The site probably consists of a thin layer of glacial ground moraine overlying shale bedrock.

Hydrologic information.--No water levels have been recorded. The direction of regional ground-water flow is probably northwestward toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected a ground-water sample from both monitoring wells in 1982 for organic-compound analyses; results are given in table C-18. Three nonpriority pollutants and one possibly naturally occurring compound were detected.

Table C-18.--Analyses of ground-water samples from Modern Disposal, site 77, Model City, N.Y., August 19, 1982.
[Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.)

	Sample number and depth below land surface (ft)	
	1 (40.6)	2 (22.7)
pH	7.6	7.0
Specific conductance (umho/cm)	880	1,175
Temperature (°C)	7.5	11.5
Organic Compounds		
Nonpriority pollutants		
1,2-Benzisothiazole-3-carboxylic acid[1]	--	17
2(3H)-Benzothiazolone[1]	—	82
Compound potentially of natural origin		
Heptacosane[1]	--	LT
Octacosane[1]	--	LT
Hexacosane[1]	--	LT

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

78a. CECOS and NYSDEC 932046
78b. NIAGARA RECYCLING (NEWCO) (Literature review) NYSDEC 932042

General information and chemical-migration potential.--These two sites, on the border of the city of Niagara Falls and the town of Niagara, are adjacent to each other and abut the Necco Park landfill (site 14).

The CECOS site is an active municipal, industrial, and chemical waste-management facility operating under New York State Department of Environmental Conservation permits. The site has received metal-finishing solids and sludges, halogenated materials, filter-press sludges, and contaminated soils.

The NEWCO site is part of CECOS and is an active sanitary landfill facility that currently receives nontoxic and municipal wastes. In the early years of operations, some hazardous waste was buried at this site.

The potential for contaminant migration offsite is indeterminable. The underlying clay and till seem sufficiently impermeable to prevent vertical migration to the bedrock. The elevated concentrations of heavy metals and barium on site 78b can probably be attributed to southward migration of leachate from the Necco Park landfill.

Both sites have had extensive geohydrologic investigations by private consultants. Borehole, water-level, and chemical data are published in the references listed herein. Maps showing the surface altitude of bedrock and of water levels in the underlying aquifers are given in figure C-36.

Geologic information.--The NEWCO site consists of fill overlying lacustrine silt and very fine sand that are underlain by 10 ft of older lacustrine clay and silt. Below is a till about 5 ft thick underlain by Lockport Dolomite. The depth to bedrock ranges from 15 to 18 ft below land surface.

The CECOS site is geologically similar and the clay, till, and bedrock extend through the area. Bedrock-surface altitude is shown in figure C-36.

Hydrologic information.--The sites have been described as having three aquifers--a water-table aquifer at the top of the clay zone, a confined zone just above the bedrock, and an upper bedrock aquifer extending to 15 ft below the bedrock surface (Wehran Engineering, 1981). Maps of the 1981 potentiometric surface of each aquifer are shown in figs. C-37, C-38, and C-39.

Ground-water flow in both the unconsolidated and bedrock aquifers is generally southward except at several ground-water mounds in the unconsolidated aquifers, which have radial flow patterns and probably affect ground-water movement within the sites. The depression in the northern part of the CECOS site (fig. C-37) can be attributed to pumping.

Wehran Engineering (1981) ran permeability tests on the underlying clay and till units. Results are as follows:

Sample no.	Soil type	Permeability (cm/s)
1	Lacustrine clay	8.6×10^{-9}
2	Lacustrine clay	5.5×10^{-9}
3	Lacustrine clay	7.1×10^{-9}
4	Lacustrine clay	1.1×10^{-8}
5	Till	6.6×10^{-8}
6	Till	4.4×10^{-8}

These low values indicate that vertical movement through these units to bedrock would be extremely slow.

Chemical information.--Extensive chemical information is available. Water samples from monitoring wells on the CECOS site show slightly elevated concentrations of calcium, sodium, and chloride, that exceed New York State ground-water standards and USEPA drinking-water criteria.

Water samples also show high concentrations of heavy metals and barium. Results of chemical analyses are given in the references cited below.

Sources of data

Calspan Corporation 1977, Soils, geology, and hydrology of the NEWCO-Niagara Recycling site, Niagara Falls, New York: Calspan Corporation, 96 p., 10 fig., 6 tables.

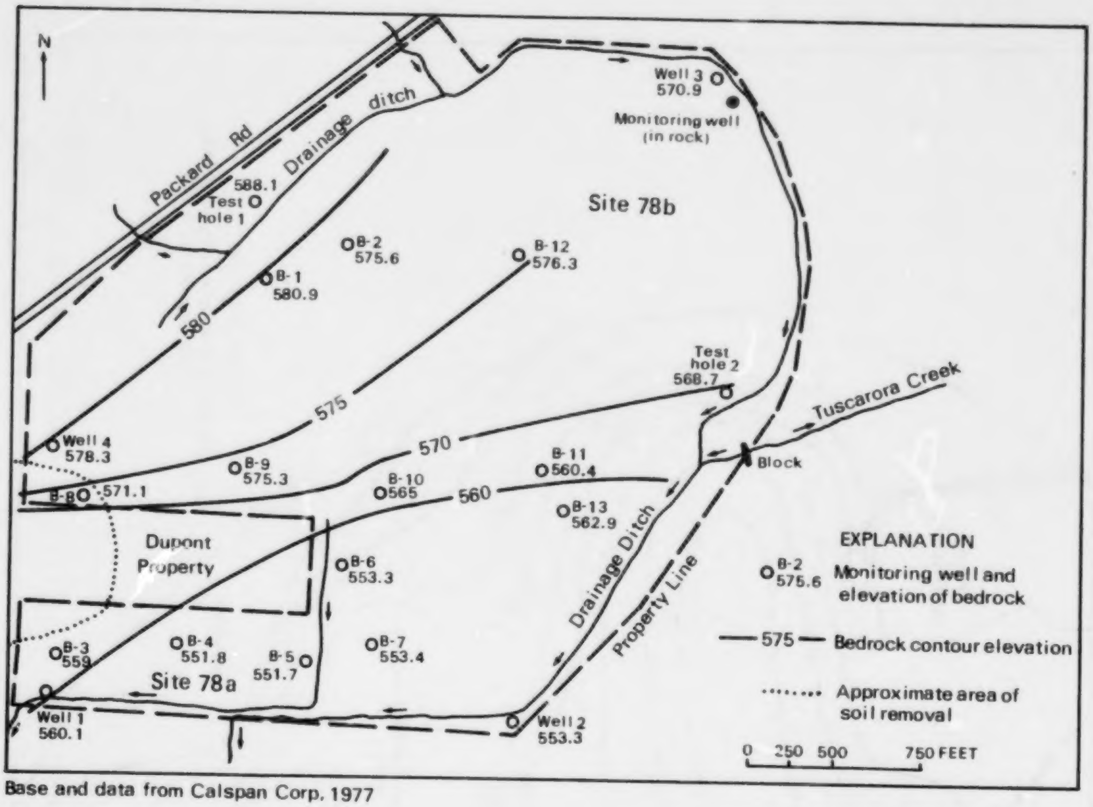
Conestoga-Rovers and Associates, 1981, Hydrogeologic investigation, acid neutralization facility, Pine Avenue/Packard Road, Town of Niagara: Conestoga-Rovers and Associates, 47 p., 25 figs., 1 table, 8 appendices.

Recra Research, Inc., 1978, Evaluation of ground-water quality in the Lockport Dolomite bedrock beneath the NEWCO-Niagara Recycling site, Niagara Falls, New York: Recra Research, Inc., 21 p., 7 attachments, 5 tables.

Wehran Engineering, 1981, Hydrogeologic-Geotechnical Investigations, Proposed sanitary landfill facilities, NEWCO Waste Systems, Inc., Pine Avenue site, Niagara Falls, New York: Wehran Engineering, 34 p., 7 figs., 5 pl., 1 table, 11 appendices.

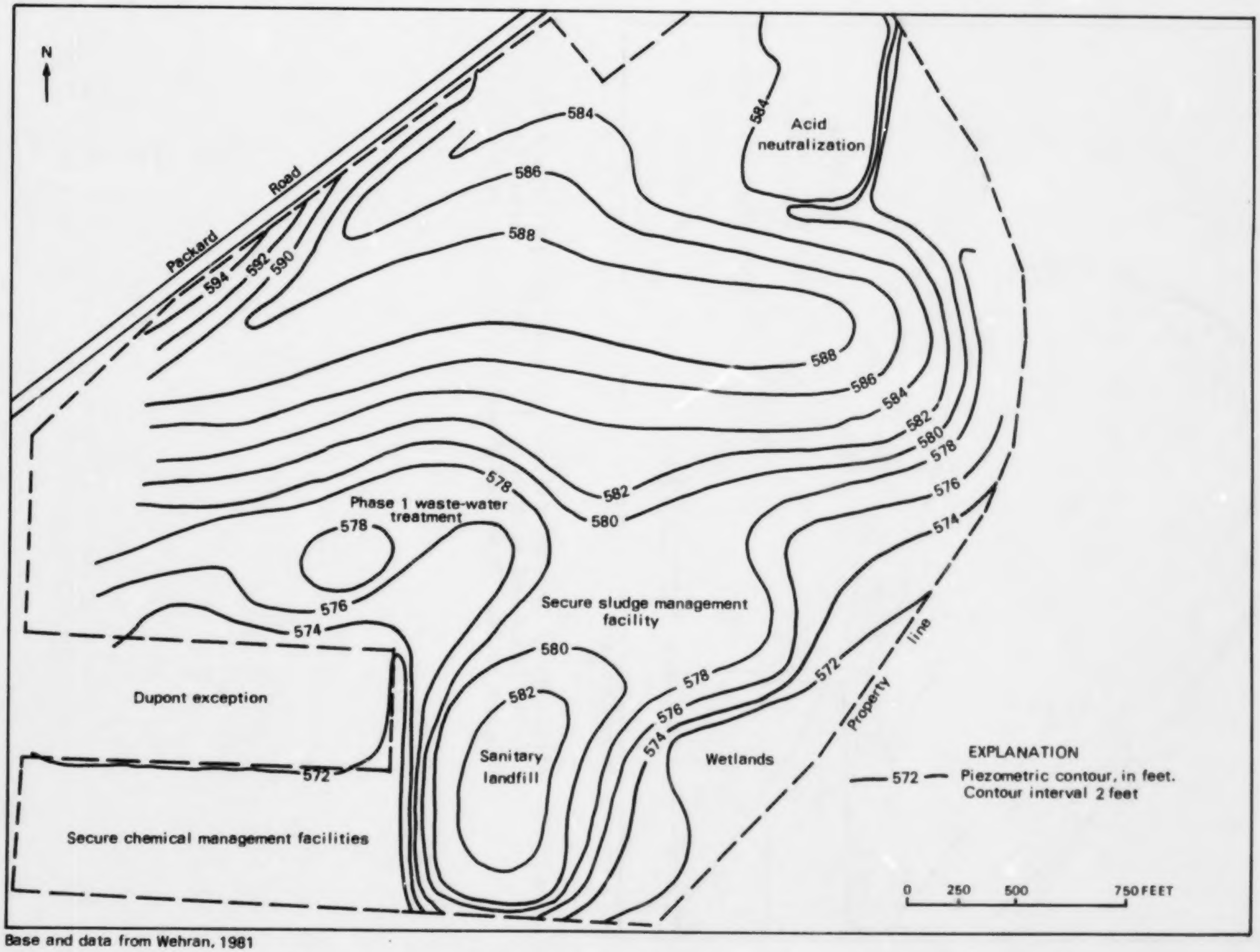
__________1981, Supplemental hydrogeologic study of the Packard Road/Pine Avenue site: Wehran Engineering, 14 p., 9 figs., 1 appendix.

Weston, R. F., Environmental Consultants-Designers, 1978, Hydrogeologic investigation of the NEWCO-Niagara Recyclying site, Niagara Falls, New York: Weston, R. F., 34 p., 17 figs., 7 tables, 5 appendices.



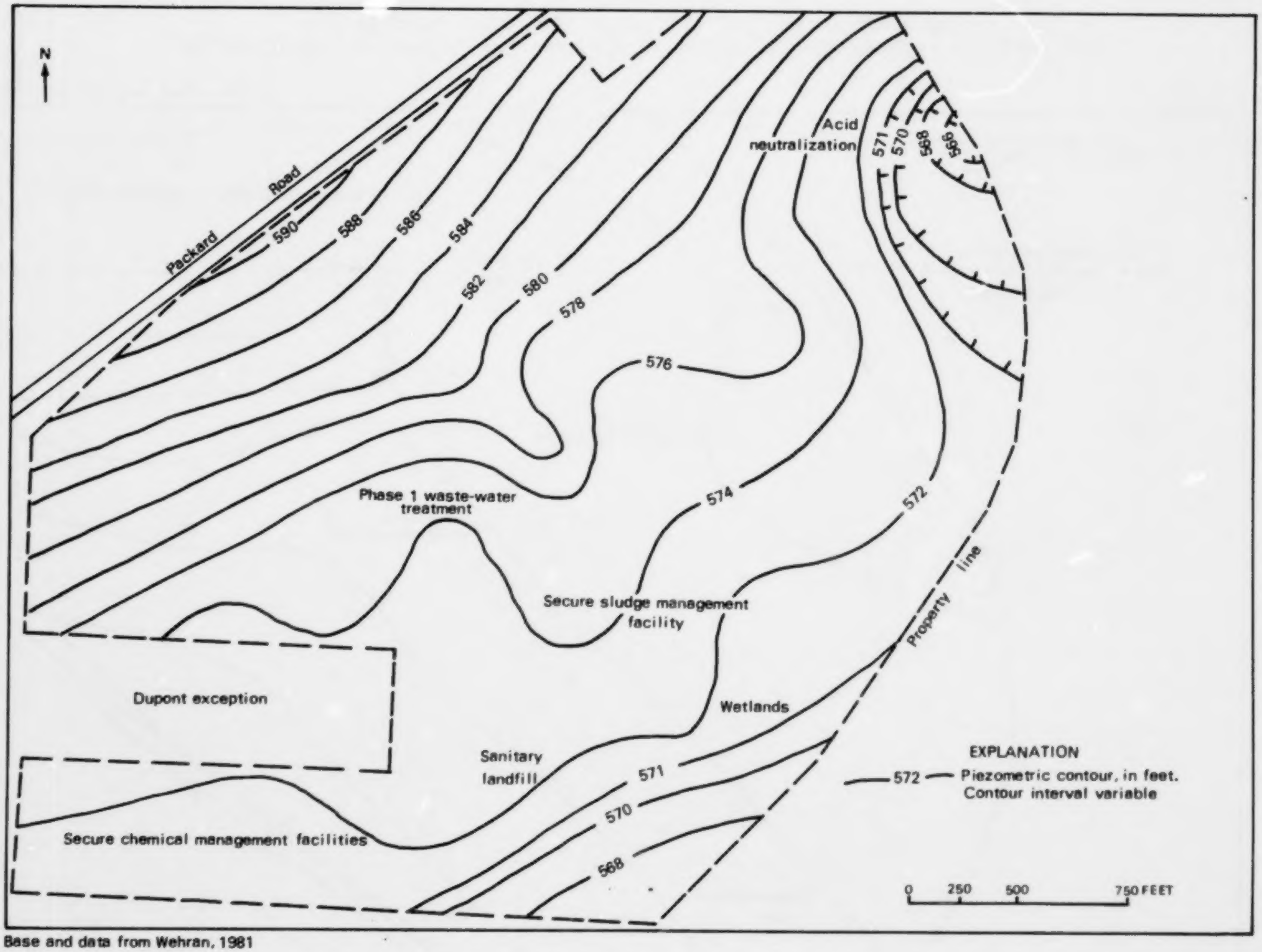
Base and data from Calspan Corp. 1977

Figure C-36. Altitudes of bedrock and ground-water in aquifer and confining unit at Cecos and Niagara Cycling (NEWCO), sites 78a and 78b, Niagara Falls. (Modified from Calspan Corp., 1977.)



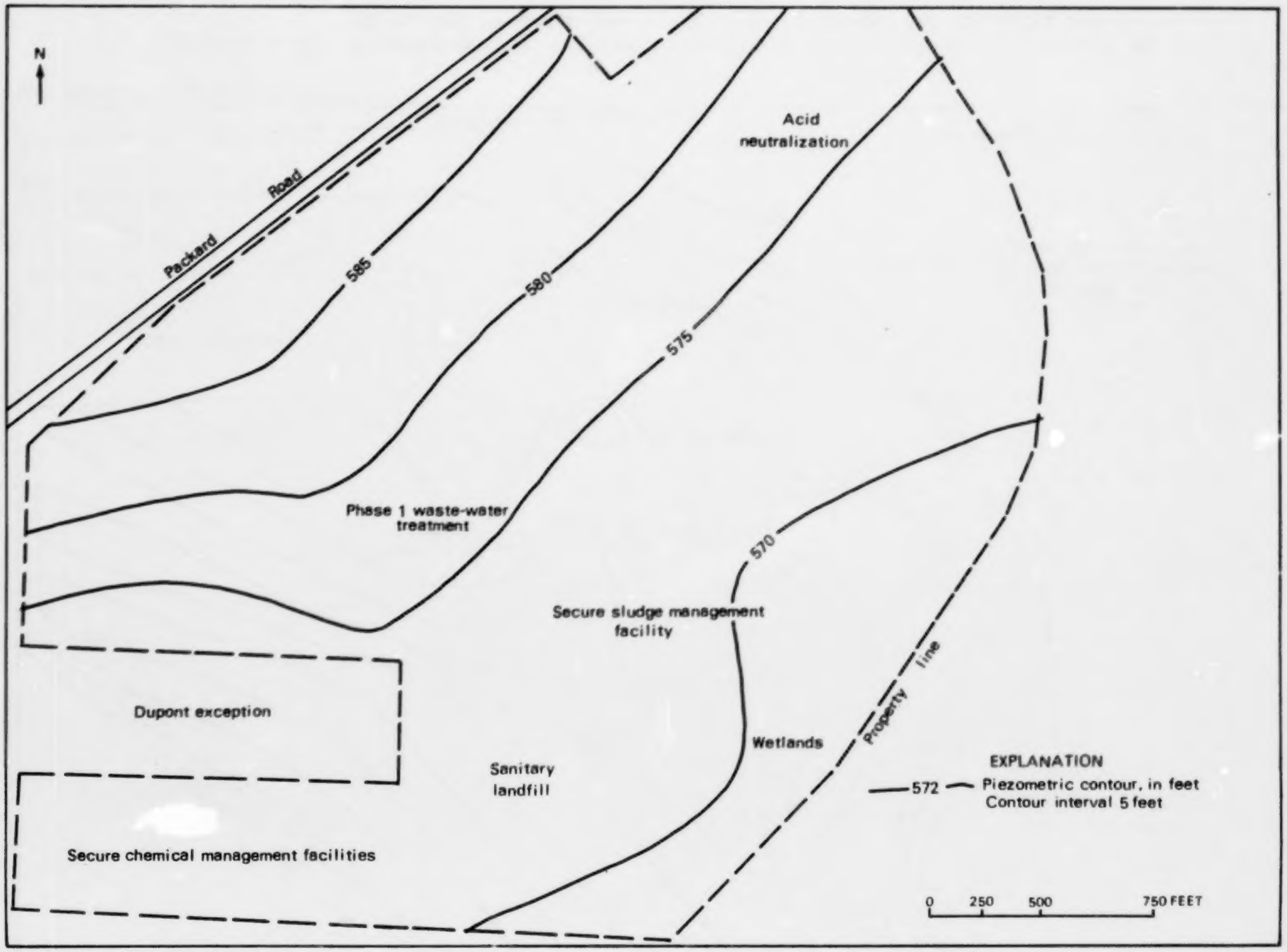
Base and data from Wehran, 1981

Figure C-37. Potentiometric surface of water-table aquifer at Cecos and Niagara Recycling, sites 78a and 78b, Niagara Falls.



Base and data from Wehran, 1981

Figure C-38. Potentiometric surface of confined aquifer above the bedrock at Cecos and Niagara Recycling, sites 78a and 78b, Niagara Falls.



Base and data from Wehran, 1981

Figure C-39. Potentiometric surface of upper bedrock aquifer at Cecos and Niagara Recycling, sites 78a and 78b, Niagara Falls.

79. POWER AUTHORITY ROAD SITE (Literature review) NYSDEC 952091

General information and chemical-migration potential.--The Power Authority Road Site, north of the Power Authority storage reservoir in the town of Lewiston, was a landfill for mostly general municipal refuse. No geologic, hydrologic, or chemical information is available; thus, the potential for contaminant migration is indeterminable.

81. NIAGARA COUNTY REFUSE DISPOSAL SITE NYSDEC 932026
(USGS field reconnaissance)

General information and chemical-migration potential.--The Niagara County Refuse Disposal site, in the town of Wheatfield, received thousands of tons of heat-treatment salts, plating-tank sludge, PVC skins and emulsion, thiazole polymer blends, polyvinyl alcohol, phenolic resins, and brine sludge with mercury during 1968-76. The site has been declared one of the U.S. Environmental Protection Agency "superfund" sites.

Although contaminant migration seems possible, preliminary sampling does not indicate that it has occurred. Most samples taken within the refuse area had elevated concentrations of organic compounds, but most samples taken along the perimeter did not. Additional drilling and monitoring would be needed to assess the effect of this site on the local or regional ground-water regime. The potential for contaminant migration is indeterminable.

Geologic information.--The site consists of lacustrine clay deposits with thin sand stringers overlying bedrock of Camillus Shale. The U.S. Geological Survey drilled 10 test holes on the site in 1982; locations are shown in fig. C-40 (p. 373). The geologic logs are on page 368.

Hydrologic information.--A seasonal water table perched upon the clay unit discharges into the bordering drainage ditches and into the swampy area to the east (fig. C-40). The saturated sand stringers within the clay unit are easily dewatered. A saturated zone near the base of the clay unit may represent a regional water table in which the direction of ground-water flow movement is probably southward toward the Niagara River.

Chemical information.--The U.S. Geological Survey collected two water samples and 10 soil samples for organic-compound analyses; results are given in table C-19. Only three priority pollutants were found, all below the quantifiable detection limit. The samples contained 18 organic nonpriority pollutants and 14 possibly naturally occurring compounds. In September 1980, the U.S. Environmental Protection Agency collected two water samples and five sediment samples from the ditches; in June 1981, New York State Department of Environmental Conservtion collected four sediment samples and four water samples from the ditches; results are given in table C-20.

Boring no.	Depth (ft)	Description
1	0 - 1.6	Topsoil.
	1.6 - 2.6	Fill.
	2.6 - 11.7	Clay, pink, tight, dry
	11.7 - 13.4	Clay, pink, wet
		SOIL SAMPLE: 11.7 ft.
2	0 - 1.5	Topsoil.
	1.5 - 10.9	Clay, tan, tight.
	10.9 - 11.4	Clay, tan, wet.
		SOIL SAMPLE: 10.9 ft.
3	0 - 1.5	Topsoil.
	1.5 - 9.5	Clay, pink, dry.
		SOIL SAMPLE: 1.5 ft.
4	0 - 0.75	Clay, pink.
	0.75 - 3.5	Organic material, black, wet.
	3.5 - 4.5	Clay, green.
	4.5 - 11.5	Clay, pink.
		SOIL SAMPLE: 3.5 ft.
6A	0 - 3.5	Clay, buff.
	3.5 - 16.5	Clay, pink.
		SOIL SAMPLE: 3.5 ft.
7	0 - 1.5	Topsoil.
	1.5 - 7.0	Clay, pink.
		SOIL SAMPLE: 1.5 ft.
8	0 - 1.5	Topsoil.
	1.5 - 6.5	Clay, pink, dry.
	6.5 - 11.5	Clay, pink, wet.
		SOIL SAMPLE: 11.5 ft.
9	0 - 1.5	Road fill.
	1.5 - 6.5	Clay, pink, dry.
	6.5 - 11.5	Clay, pink, wet.
		SOIL SAMPLE: 11.5 ft.
10	0 - 1.5	Clay, sandy, gray.
	1.5 - 3.0	Clay, pink.
		SOIL SAMPLE: 1.5 ft.
11	0 - 1.5	Clay, sandy, gray.
	1.5 - 3.0	Clay, pink.
		SOIL SAMPLE: 1.5 ft.

Table C-19.--Analyses of ground-water and substrate samples from Niagara County Refuse Disposal, site 81, Wheatfield, N.Y., June-August 1982. [Locations shown in fig. C-40. Concentrations are in μg/L and μg/kg, respectively; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit. Blanks indicate not analyzed.]

	Substrate number and depth below land surface (ft)			
	1 (12.5)	2 (11.2)	3 (1.5)	4 (2.2)
Organic compounds				
Priority pollutants				
Naphthalene	LT	--	--	--
Dibutyl phthalate	--	LT		
Nonpriority pollutants				
2,4-dimethyl-4-heptanol[1]	--	LT	--	--
2-(1,1-dimethyl-4-methyl furan[1]	--	LT	--	--
Bromocyclohexane[1]	--	4,350	--	--

	Sample number and depth below land surface (ft)				
	Ground water			Substrate	
	5 (12.4)	6 (15.7)	(Duplicate)	6A	7
pH	9.2	8.4			
Specific conductance (μmho/cm)	475	620			
Temperature (°C)	10.0	10.0			
Organic compounds					
Priority pollutants					
Diethyl phthalate	--	LT	(LT)	--	--
Di-n-butyl phthalate	--	LT	(LT)	--	--
Nonpriority pollutants					
n-butylbenzene sulfonamide[1]	--	7.2	(LT)	--	--
butyl-2-methyl-propyl phthalate[1]	--	LT	(--)	--	--
3,5-Dimethoxy-α-(2-methyl-propyl)-benzenementhanol[1]	--	9.2	(--)	--	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water.

Table C-19.--Analyses of ground-water and substrate samples from Niagara County Refuse Disposal, site 81, Wheatfield, N.Y., June-August 1982 (continued)

	Sample number				
	Ground water			Substrate	
	5	6	(Duplicate)	6A	7
Organic compounds (continued)					
Nonpriority pollutants (continued)					
Hexadecanoic acid, bis-(2-ethyhexl)-ester[1]	--	LT	(--)	--	--
Benzaldehyde[1]	--	LT	(LT)	--	--
3-methoxybenzoic acid, methylester[1]	--	--	(LT)	--	--
1-Heptyne[1]	LT	--	(--)	--	--
[1,1'-Biphenyl]-2-ol	7	--	(--)	--	--
2-(1,1-Dimethylethyl)-4-methylfuran[1]	--	--	(--)	104,000	--
1-(4-fluorophenyl)-ethanone[1]	--	--	(--)	55,900	--
(Z,Z)-3,4-Dimethyl-2,4-hexadiene[1]	--	--	(--)	LT	--
6-methyl-3,5-heptadien-2-one[1]	--	--	(--)	11,800	--
3-methyl-2-cyclohexen-1-one[1]	--	--	(--)	LT	--
3,5,5-Trimethyl-2-cyclohexen-1-one[1]	--	--	(--)	65,800	--
2-Bromoethylcyclohexane[1]	--	--	(--)	16,700	--
2-(2-Butoxyethoxy)ethanol[1]	--	--	(--)	--	430
1-(2-butoxyethoxy)ethanol[1]	LT	43	(84)	--	--
2-methylnapthalene[1]	--	LT	(--)	--	--
1-methylnapthalene[1]	--	LT	(--)	--	--
Butyl-cyclooctane[1]	--	LT	(LT)	--	--
2-methyl-propanoic acid, butyl ester[1]	--	LT	(--)	--	--
2-methoxy-benzoic acid, butyl ester[1]	--	LT	(--)	--	--
3-methoxy-benzoic acid, methyl ester[1]	--	LT	(--)	--	--
5-butyl-5-nonanol[1]	--	LT	(LT)	--	--
Cyclohexanone[1]	--	--	(--)	--	LT
Compounds potentially of natural origin					
1,7,7-Trimethyl-bicyclo[2.2.1]-heptan-2-one[1]	--	LT	(--)	--	--
1,2-octanediol[1]	--	LT	(LT)	--	--

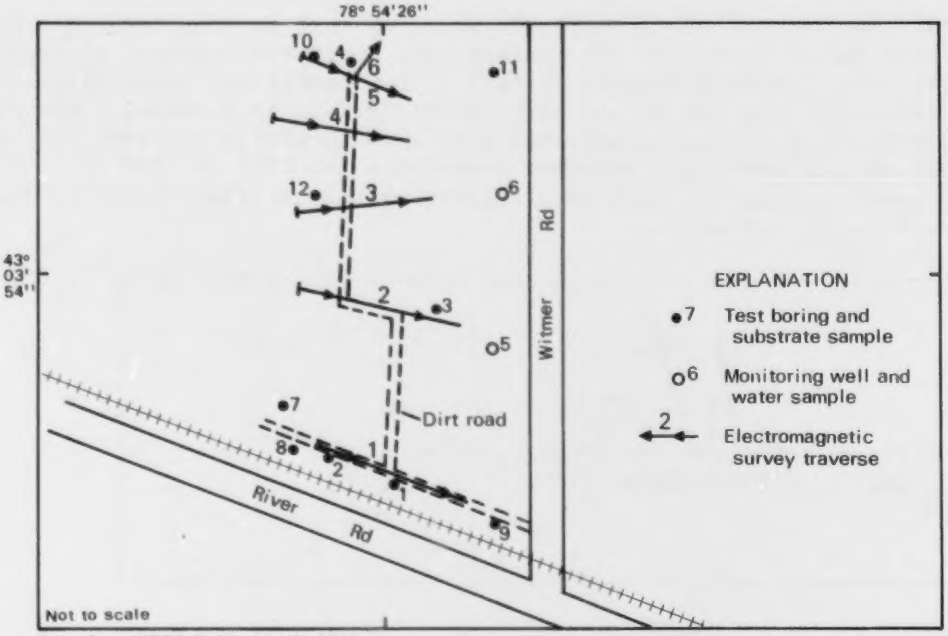
	Substrate number and depth below land surface (ft)			
	8 (11.5)	9	10 (1.5)	11 (1.5)
Organic compounds	--	--	--	--

Table C-20.--Analyses of surface water and bottom samples from drainage ditches at Niagara County Refuse Disposal, site 81, Wheatfield, N.Y. [Blanks indicate not analyzed.]

	Surface water (µg/L)		Bottom material (µg/kg)	
	Maximum	Mean	Maximum	Mean
Inorganic constituents				
Antimony			4,000	2,600
Arsenic	30	25	7,800	6,300
Beryllium			16,000	10,600
Cadmium			3,800	800
Chromium			23,000	14,100
Copper	52	20	61,000	34,000
Lead	160†	32	84,000	47,000
Mercury	1.58	0.4	14,200	3,200
Nickel	100	20	45,000	16,400
Selenium			200	60
Silver			400	240
Zinc	174	61	1,500,000	390,000
Organic compounds				
Priority pollutants				
Benzene			0.5	0.2
Chlorobenzene			5	1
Chloroform			4	2
1,2-Dichloroethane			4	1
Trans-1,2-dichloroethylene	37†	7†	12	2
1,2-Dichloropropane			1	1
Ethylbenzene	8	2	3	1
Methylene chloride	2	1	31	15
Tetrachloroethylene	56	11	19	4
Toluene	31	6	4	1
1,1,1-Trichloroethane			0.5	0.1
Trichloroethylene	8	2	5	2
Vinyl chloride	2	0.4		
β-BHC			58	6
δ-BHC			90	10
4,4'-DDE			11	3
PCB-1248			320	53
PCB-1254			180	37
Phenol	34,000†	5,666†	1,900	333
Acenaphthene			17	4
Acenaphthylene			130	14
Anthracene			2,000	273
Benzo(a)pyrene			2,300	299
Benzo(b)fluoranthene			2,200	282
Benzo(ghi)perylene			7,605	845
Bis(2-ethylhexyl) phthalate	330	57	6,900	2,444
Butylbenzyl phthalate	0.8	0.1	330	64
Chrysene			3,200	356
1,2-Dichlorobenzene			39	8
1,3-Dichlorobenzene			59	17

Table C-20.--Analyses of ground-water and substrate samples from Niagara County Refuse Disposal, site 81, Wheatfield, N.Y., June-August 1982 (continued)

	Surface water (µg/L)		Bottom material (µg/kg)	
	Maximum	Mean	Maximum	Mean
Organic compounds (continued)				
Priority pollutants (continued)				
1,4-Dichlorobenzene			59	17
Di-n-butyl phthalate	9	2	470	217
Di-n-octyl phthalate	10	2	170	19
Fluoranthene			2,500	319
Fluorene			93	15
Hexachlorobenzene			39	4
Naphthalene			160	34
Phenanthrene			2,000	273
Pyrene			2,000	254
1,2,4-Trichlorobenzene			47	6
Benzo(a)anthracene			3,200	356
Indeno(1,2,3-cd)pyrene			820	91
2,4-Dimethyl phenol			990	110
Heptachlor	0.13†	0.04†		
Nonpriority pollutants				
Trichlorofluoromethane			1	0.2
Diethyl phthalate	40	7	180	67


78° 54'26''
10
4
6
5
11
4
12
3
6
43°
03'
54''
2
3
5
Witmer Rd
7
8
2
1
1
Dirt road
River Rd
9
Not to scale
EXPLANATION
•7 Test boring and substrate sample
o6 Monitoring well and water sample
2 Electromagnetic survey traverse

Base from USGS field sketch, 1982

Figure C-40. Location of monitoring wells, sampling holes, and electromagnetic-conductivity survey at Niagara County Refuse Disposal, site 81, Niagara Falls.

Electromagnetic survey.--The U.S. Geological Survey ran five electromagnetic traverses over the site. Locations are shown in fig C-40; results are plotted in fig. C-41.

Of all the sites investigated by electromagnetic traverses in this study, this landfill produced some of the most easily interpretable data. This can be attributed largely to the relatively undisturbed ground on three sides adjacent to the site. Only to the south of the landfill did cultural interference (railroad tracks, roads, powerlines) affect the reading.

Line 1.--The line most indicative of interferences was line 1, which ran partly along a paved road. Conductivity values (fig. C-41) show a steady increase from below background at the western end to above background between 450 and 700 ft. After 700 ft, the values hover near the upper ranges of background conductivity.

Line 2.--This site is unusual in having two zones of differing background conductivity. The western end of each line terminated within a cornfield showing background conductivity within the range indicated on each graph (fig. C-42), but the eastern part of lines 1 and 2 were in a wetland, which has a considerably lower background conductivity. This is probably because the wetlands are underlain by silt and organic material, whereas the cornfield is on clay.

The lower conductivity of the wetlands shows up well in line 2 but is masked on the eastern end of line 1 by the roadbed upon which the traverse was conducted. Otherwise line 2 shows a classic pattern of low background conductivities on either side with much higher and more erratic values in between. This is the type of pattern most often associated with a conductivity traverse beginning and ending in an uncontaminated zone but crossing a landfill in between. The erratic pattern among the high conductivity values corresponds to the heterogeneity of buried materials.

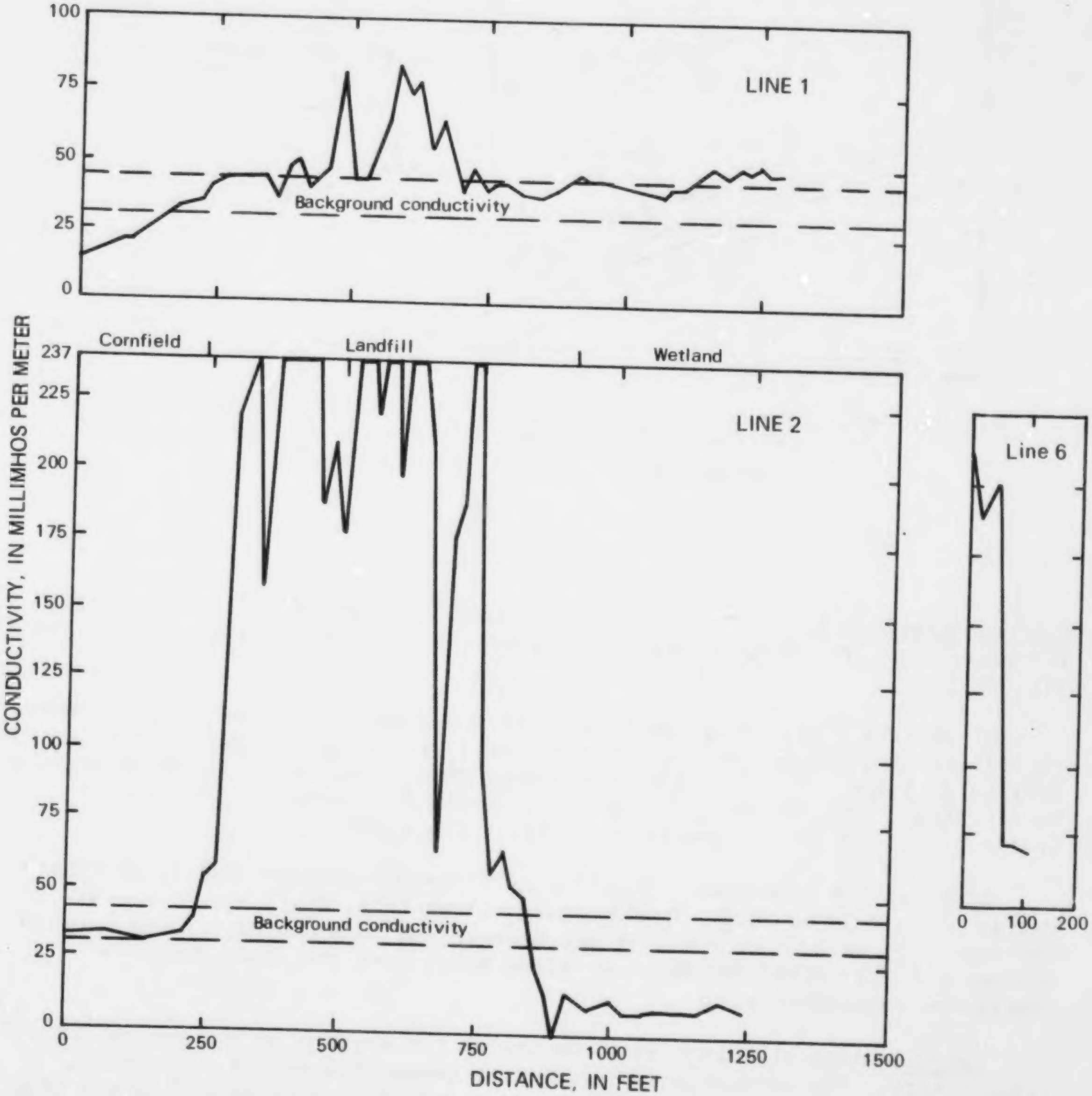


Figure C-41. Results of electromagnetic-conductivity survey at Niagara County Refuse Disposal, site 81, Wheatfield, lines 1, 2, and 6.

Line 3.--The relatively low values at the western end of line 3 probably reflect the wetland and drainage ditch, which seem to act much as the wetland area in line 2. The high, erratic values of line 3 begin at 340 ft and continue to the dense woods around the 1,100-ft mark. The density of vegetation prevented the collection of additional data points within the wooded area.

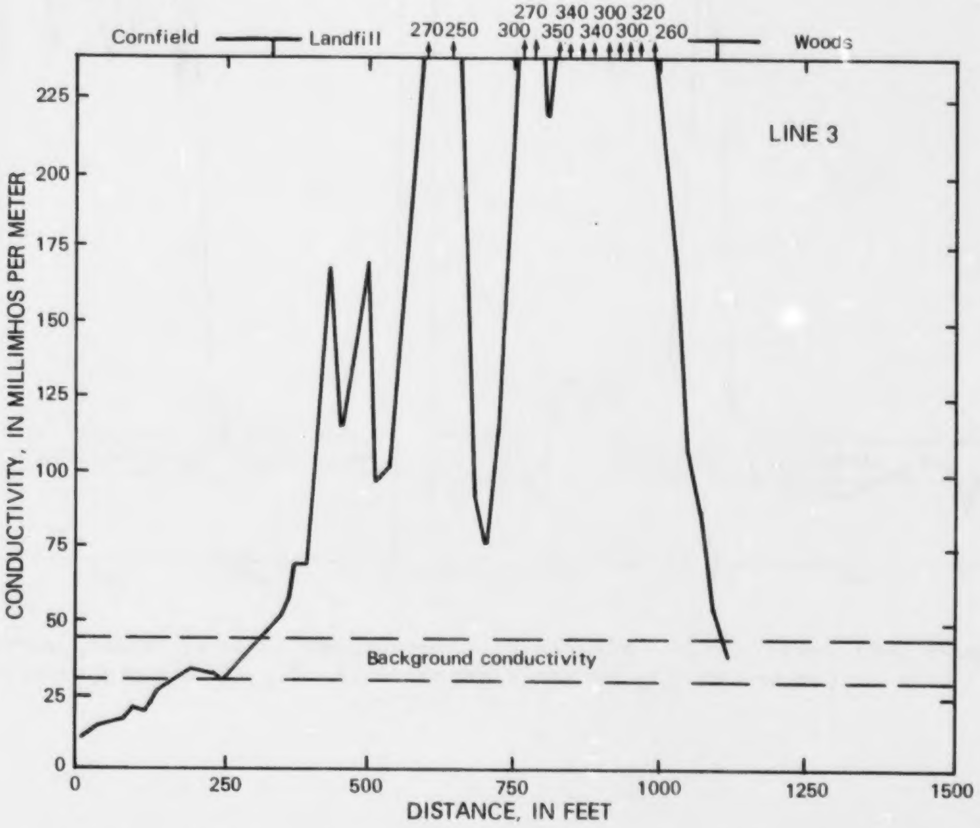


Figure C-41 (continued). Results of electromagnetic-conductivity survey at Niagara County Refuse Disposal, site 81, Wheatfield, line 3.

Line 4.--This traverse, which ran primarily along a dirt track paralleling a drainage ditch, shows conductivity values beginning to rise 40 ft before reaching the landfill area (at 460 ft) but not remaining extremely high along much of the traverse. This is probably due to the relatively nonconductive nature of the waste material in this area (indicated on the Niagara County Board of Health sketch map as a pile of gravel and fill). As before, when the traverse reached the wooded area at 800 ft, the conductivity values dropped to or below background values.

Line 5.--This line shows a pattern similar to line 2--the background values on the western end of the line begin to increase 40 ft before the boundaries of the landfill. This rise may correspond to contaminated ground water emanating from the site.

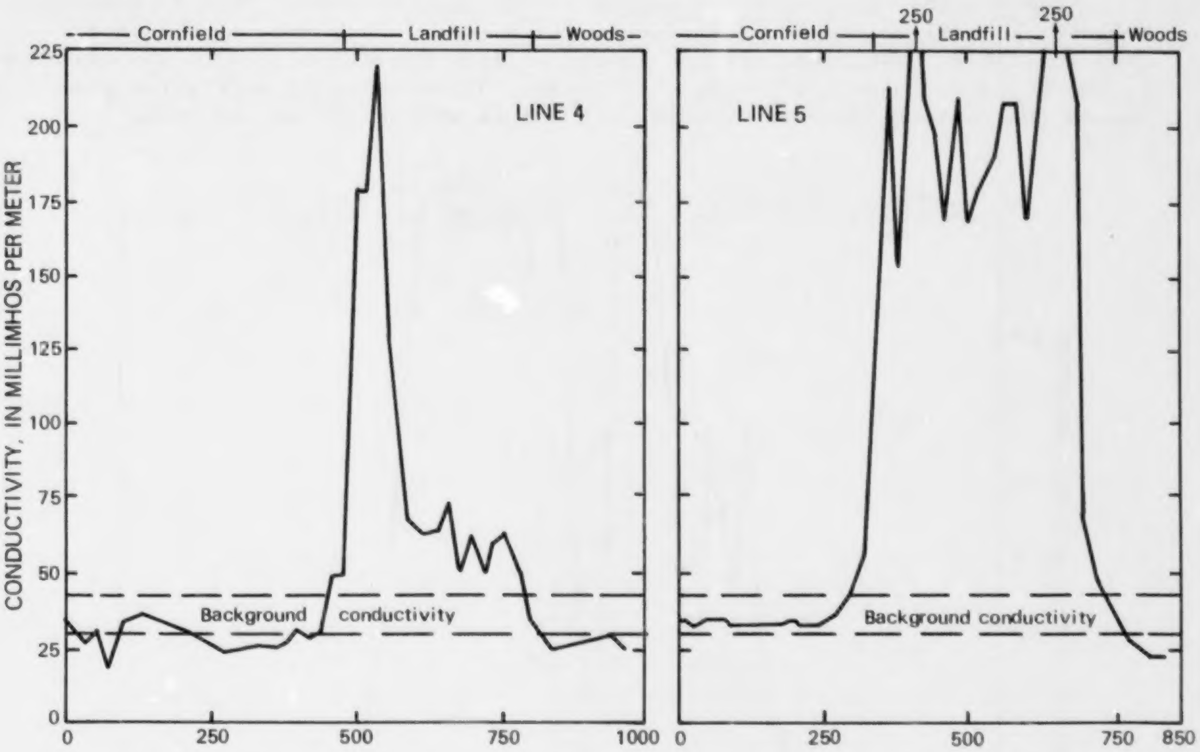


Figure C-41 (continued). Results of electromagnetic-conductivity survey at Niagara County Refuse Disposal, site 81, Wheatfield, lines 4 and 5.

Line 6.--This line (see p. 371) was run at right angles to the 420-ft mark of line 5 in an attempt to delineate the northern boundary of the landfill. Conductivity values drop precipitously at the 120 ft mark, but no futher data could be collected owing to the impassability of the terrain in this direction.

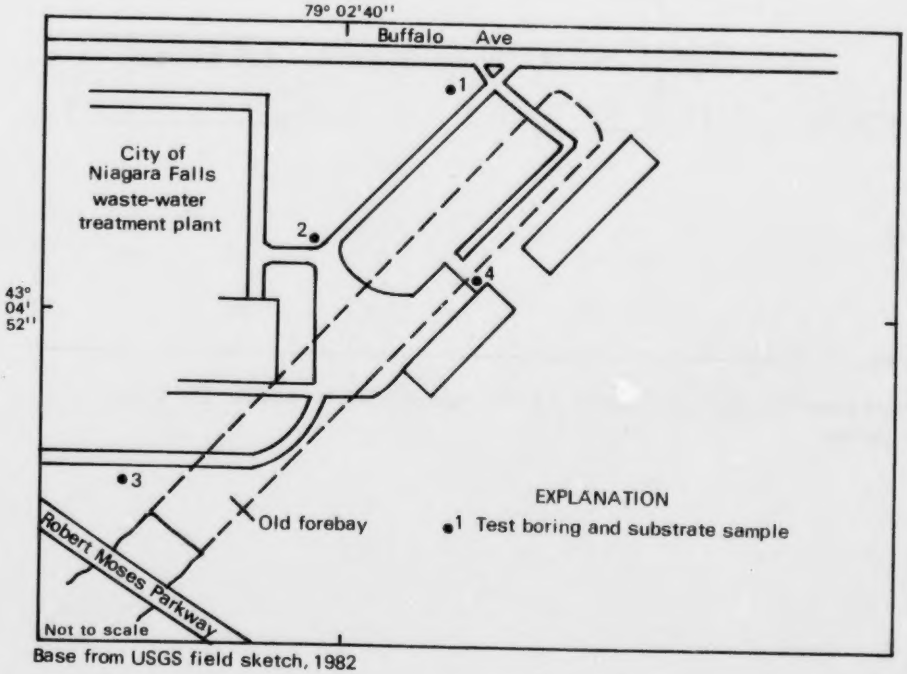
82. ADAMS GENERATING PLANT (USGS field reconnaissance) NYSDEC 932079

General information and contaminant-migration potential.--The Adams Generating Plant, in the city of Niagara Falls, is an inactive generating plant adjacent to the Niagara River. The City filled a forebay and two penstocks (444 yd^3 each) with incinerator residue and clean stone and rock in the early 1960's.

The potential for contaminant migration is indeterminable. Additional work would be needed to confirm contaminant migration.

Geologic information.--The site consists of fill and clay overlying bedrock of Lockport Dolomite. The Geological Survey drilled four test holes on the site in 1982; locations are shown in figure C-42. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 6.0	Brown topsoil.
	6.0 - 9.0	Gravel at 6.0 to 6.5 ft. "Shot rock" at 6.5 to 9.0 ft.
		SAMPLE: 8.0 ft.
2	0 - 2.0	Topsoil, could not drill past 2.0 ft, moved to new spot.
	0 - 3.0	Topsoil.
	3.0 - 5.0	Dark brown soil at 3.0 ft.
	5.0 - 7.0	Clay, sandy, damp, tannish green.
	7.0 -11.0	Clay, reddish, sandy, gravel lens.
		SAMPLE: 8.0 ft.
3	0 - 5.0	Topsoil.
	5.0 - 7.0	Clay, brown.
	7.0 -10.5	Clay, reddish, gravelly.
		SAMPLE: 10.0 ft.
4	0 - 5.0	Top soil with gravel.
	5.0 - 8.0	Clay, brown, sandy, with some gravel.
	8.0 -10.0	Clay, light gray, pea gravel, damp.
	10.0 -10.5	Clay, slate gray, damp.
		SAMPLE: 10.0 ft.



Base from USGS field sketch, 1982

Figure C-42. Location of sampling holes at Adams Generating Plant, site 82, Niagara Falls.

Hydrologic information.--No ground water was encountered during the test drilling. If ground water occurs in the unconsolidated deposits, the direction of flow would be toward the filled forebay and the Niagara River.

Chemical information.--The U.S. Geological Survey collected four soil samples for chromium, copper, iron, mercury, and organic-compound analyses; results are given in table C-21. Copper exceeded background levels in sample 4, and three organic priority pollutants were found in sample 4 but in concentrations below the quantifiable detection limit. These data may not represent actual conditions at the site because the sampling locations and depths may not be representative of the deep, extensive fill in the penstocks and forebay.

Table C-21.--Analyses of substrate samples from Adams Generating Plant, site 82, Niagara Falls, N.Y., July 27, 1982. [Locations shown in fig. C-48. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.)

	Sample number and depth below land surface (ft)			
First sampling (07-27-82)	1 (8.0)	2 (8.0)	3 (10.0)	4 (10.5)
Inorganic constituents				
Chromium	5,000	5,000	6,000	6,000
Copper	10,000	9,000	9,000	24,000††
Iron	1,300,000	1,500,000	3,800,000	13,000,000
Mercury	--	--	--	--
	Sample number and depth below land surface (ft)			
Second sampling (05-28-83)	1A (3.0)	2A (7.0)	3A (4.0)	4A (7.0)
Organic compounds				
Priority pollutants				
Fluoranthene	--	--	--	LT
Phenanthrene	--	--	--	LT
Pyrene	--	--	--	LT

†† Exceeds concentrations in samples taken from undisturbed soils in the Niagara Falls area.

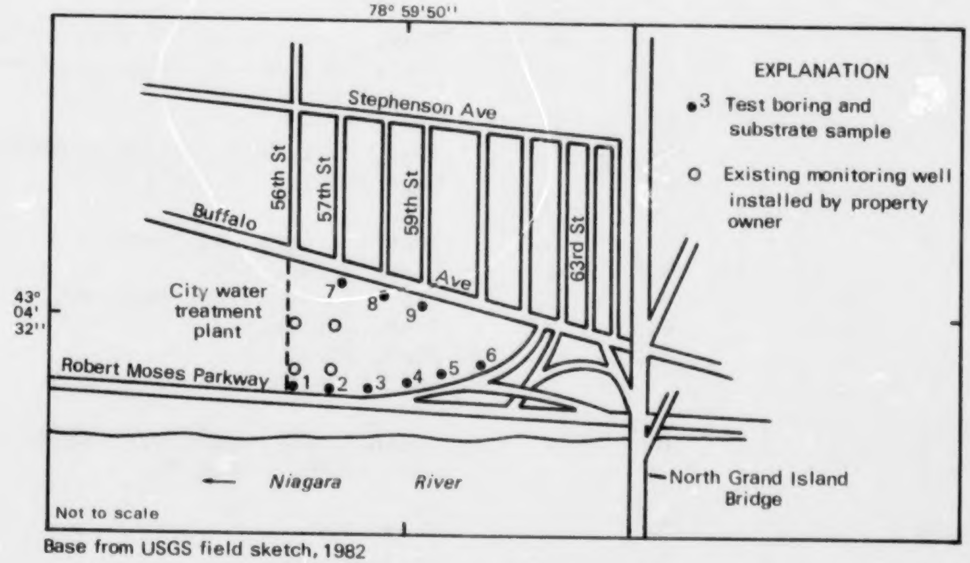
83. BUFFALO AVENUE (USGS field reconnaissance) NYSDEC 932080

General information and chemical-migration potential.--The Buffalo Avenue site, in the city of Niagara Falls between Buffalo Avenue and Robert Moses Parkway, was formerly a wetland on which the City of Niagara Falls buried an unknown quantity of noncombustibles and incinerator residue during 1930-50. Traprock fill was used along the southern part of the area during construction of the parkway.

Hydrogeologic and chemical data indicate a major potential for contaminant migration because ground water can flow unimpeded through the fill to the river. Chemical results show elevated concentrations of several organic compounds. A map showing locations of borings is given in fig. C-43.

Geologic information.--The site consists of several extensive areas of fill overlying clay, till, and alluvium. The unconsolidated material is approximately 30 ft thick. The underlying bedrock is Lockport Dolomite. The U.S. Geological Survey drilled 32 test holes on the site, but 23 could go no deeper than 1 ft because of the rock fill. Locations of the nine test holes from which a soil sample was obtained are shown in fig. C-43. The geologic logs are on page 380.

Hydrologic information.--Water levels indicated a maximum water-table altitude of 565 ft above NGVD in the two northern wells and 562 ft above NGVD in the two southern wells. The direction of ground-water flow is southward toward the Niagara River.


78° 59'50''
EXPLANATION
•3 Test boring and substrate sample
o Existing monitoring well installed by property owner
Stephenson Ave
56th St
57th St
59th St
63rd St
Buffalo
Ave
City water treatment plant
43° 04' 32''
Robert Moses Parkway
1
2
3
4
5
6
7
8
9
Niagara River
North Grand Island Bridge
Not to scale

Base from USGS field sketch, 1982

Figure C-43. Location of sampling holes at Buffalo Avenue, site 83, Niagara Falls.

Boring no.	Depth (ft)	Description
1	0 - 11.5	Fill material, boulders.
	11.5 - 26.5	Clay, dark gray, sandy, wet.
		SOIL SAMPLE: 26.5 ft.
2	0 - 2	Topsoil.
	2	Fill.
		SOIL SAMPLE: 2 ft.
3	0 - 2.5	Topsoil.
	2.5	Fill.
		SOIL SAMPLE: 2.5 ft.
4	0 - 1.5	Topsoil.
	1.5 - 4.0	Clay, brown, boulder fragments.
	4.0 - 6.5	Clay, reddish, still some rock fragments, sandy.
	6.5 - 6.7	Same, above 6 in of water in hole.
		SOIL SAMPLE: 6.7 ft.
5	0 - 4	Clay, reddish, brown, sandy.
		SOIL SAMPLE: 4 ft.
6	0 - 4	Clay, brown, some black material.
	4 - 8	Clay, tan, sandy, damp, gray sandy clay on bit.
	8 - 10	Clay, pink.
	10 - 15	Clay, dark brown, black material.
		SOIL SAMPLE: 7 - 8 ft.
7	0 - 3.5	Topsoil, organic, black.
	3.5 5	Clay, sandy, tan.
	5 - 6.5	Clay, sandy, light tan, wet.
	6.5 - 9.0	Same, wetter.
	9.0	Clay, pink.
		SOIL SAMPLE: 5 - 6.5
8	0 - 4	Topsoil and brown, wet, sandy clay.
		SOIL SAMPLE: 4.0 ft.
9	0 - 4	Clay, tan.
	4 - 7	Clay, gray.
		SOIL SAMPLE: 4.0 ft.

Chemical information.--The U.S. Geological Survey collected nine soil samples for iron, mercury, and organic-compound analyses; results are given in table C-22. The samples contained 12 organic priority pollutants and 10 organic nonpriority pollutants. Most organic priority pollutants in sample 1 were in concentrations above 1,500 μg/kg.

Table C-22.--Analyses of substrate samples from Buffalo Avenue, site 83, Niagara Falls, N.Y.

[Locations shown in fig. C-43. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)				
	1	(Split)	2	3	4
First sampling (6-25-82)	(26.5)		(2.0)	(3.0)	(6.7)
Inorganic constituents					
Iron	3,800,000	(3,500,000)	1,400,000	4,800,000	9,900,000
Mercury	--	(--)	--	--	--
Organic compounds		***	***	***	***
Priority pollutants					
Phenanthrene	4,200	(5,300)	--	--	--
Flouranthene	3,800	(5,700)	--	--	--
Pyrene	3,500	(5,900)	--	--	--
Benzo(a)anthracene	1,600	(2,400)	--	--	--
Chrysene	2,600	(3,600)	--	--	--
Benzo(b)fluoranthene	750	(1,900)	--	--	--
Benzo(k)fluoranthene	LT	(2,200)	--	--	--
Benzo(a)pyrene	1,400	(4,000)	--	--	--
Nonpriority pollutants					
5-Methyl-3-hexen-2-one[1]	LT	(--)	--	--	--
2,6-Dimethyl-2,5-hepta-dien-4-one[1]	3,100	(12,000)	--	--	--
4,5,7-Trimethylindan[1]	360	(--)	--	--	--
(E)-4-(2-Butenyl)-1,2-dimethylbenzene[1]	--	(1,400)	--	--	--
Compounds potentially of natural origin					
2,3,8-Trimethyldecane[1]	--	(3,400)	--	--	--
2,7-Dimethylundecane[1]	--	(2,000)	--	--	--
Nonadecane[1]	--	(2,100)	--	--	--
7-Hexyldocosane[1]	--	(1,600)	--	--	--
Heptacosane[1]	--	(1,800)	--	--	--
2,4-Dimethyl-4-heptanol[1]	--	(1,800)	--	--	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

***Samples analyzed at detection limit above that required by this study.

Table C-22.--Analyses of substrate samples from Buffalo Avenue, site 83, Niagara Falls, N.Y. (continued)
[Locations shown in fig. C-43. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

First sampling (6-30-82)	Sample number and depth below land surface (ft) 5 (4.0)	 6 (6.0)	 7 (6.5)	 (Split)
Inorganic constituents				
Iron	1,100,000	11,000,000	6,700,000	(2,900,000)
Mercury	--	--	--	(--)
Organic compound			***	***
Priority pollutant				
Naphthalene	--	LT	--	(--)

First sampling (6-30-82)	Sample number and depth below land surface (ft) 8 (4.0)	 (Split)	 9 (4.0)
Inorganic constituents			
Iron	6,800,000	(1,300,000)	
Mercury	--	(--)	
Organic compounds	***	***	***

Second sampling (5-28-83)	Sample number and depth below land surface (ft) 2A (2.0)	 3A (2.0)	 4A (1.5)
Organic compounds			
Priority pollutants			
4,4-DDT	25	--	--
Hexachlorobenzene	LT	--	--
Hexachlorobutadiene	LT	--	--

Second sampling (5-28-83)	Sample number and depth below land surface (ft) 7A (5.0)	 8A (4.0)	 9A (5.0)
Organic compounds	--	--	--

84. CAYUGA ISLAND (USGS field reconnaissance) NYSDEC 932008

General information and chemical-migration potential.--Cayuga Island is in the Niagara River at the outlet of Cayuga Creek in the city of Niagara Falls. The west end was extended with an unknown quantity of concrete rubble and other solid debris. No hazardous material is known to be buried on the site.

This site probably has a major potential for contaminant migration because the rubble and the direct hydraulic connection with the river provide for rapid movement of water, and certain contaminants are present in the ground water in significant concentrations. However, additional monitoring would be needed to confirm the extent and rate of contaminant migration; therefore, the potential for contaminant migration is indeterminable.

Geologic information.--The island consists of rock, concrete, brick, and fill. The U.S. Geological Survey drilled one test boring in the fill area on the western point of the island in 1982; the depth to bedrock (Lockport Dolomite) was 26.5 ft. In 1983, the Geological Survey drilled an additional test boring 2 ft deep further inland and collected a substrate sample.

Hydrologic information.--The U.S. Geological Survey installed one monitoring well on the site in 1982. The screened zone is from 24.5 to 26.5 ft below land surface. The water level in January 1983 was approximately 565 ft above NGVD--approximately the height of the river. Ground-water flow is probably toward the river.

Chemical information.--The U.S. Geological Survey collected one water sample from the monitoring well for cadmium, chromium, copper, iron, lead, zinc, and organic-compound analyses; results are given in table C-23. Iron, zinc, and phenol concentrations exceeded USEPA criteria for drinking-water standards. The samples contained 16 organic priority pollutants and two organic nonpriority pollutants. Isomers of hexachlorocyclohexane (BHC), which include Lindane, were found in both the water sample near the shore and in the soil sample about 100 ft inland.

Table C-23.--Analyses of ground-water and substrate samples from Cayuga Island, site 84, Niagara Falls, N.Y.
[Concentrations are in µg/L and µg/kg; LT indicates it was found but below the quantifiable detection limit. Blanks indicate not analyzed.]

First sampling at 6.0 ft (1-12-83)	Ground water		
Inorganic constituents			
Cadmium	2		
Chromium	4		
Copper	9		
Iron	29,000†		
Lead	21		
Zinc	7,000†		
Organic compounds			
Priority pollutants			
1,2,4-Trichlorobenzene	6.8	1,2-Dichlorobenzene	6.7
Naphthalene	1.6	Trichloroethene[1]	LT†
Dimethyl phthalate	1.5	Chlorobenzene[1]	LT
Di-n-butyl phthalate	7.3	γ-BHC(Lindane)[2]	5.9†
Bis(2-ethylhexyl) phthalate	4.0	δ-BHC[2]	6.6†
Phenol	89†	ξ-BHC[2]	11†
1,3-Dichlorobenzene	8.1		
Nonpriority pollutants			
Diethyl phthalate	8.5	α-BHC[2]	97†
N-(4-Chlorophenyl)acetamide[3]	2.0		
1-Chloro-4-ethoxybenzene[3]	1.4		
Second sampling at 2.0 ft (5-28-83)	Substrate		
Organic compounds			
Priority pollutants			
α-BHC	LT		
β-BHC	LT		
δ-BHC	LT		

---

[1] Volatile found in GC/MS extraction. Concentration at time of sampling probably higher than that detected.

[2] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts. For quantitation, pesticides are analyzed through electron capture.

[3] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

85. GRIFFON PARK (USGS field reconnaissance) NYSDEC 932081

General information and chemical-migration potential.--Griffon Park, in the city of Niagara Falls at the mouth of the Cayuga Island Little River, was used to dispose mostly of leaves and forestry materials of unknown quantity. Some domestic wastes may have been included.

The hydraulic connection with the Little River of Cayuga Island indicates a major potential for contaminant migration. Chemical analyses of soil samples indicate contamination; but analyses of a ground-water sample indicate limited migration. Additional testing would be needed to delineate the extent of contaminant migration.

Geologic information.--The site contains approximately 34 ft of unconsolidated deposits of lacustrine clay and till overlying bedrock that is probably dolomitic. The U.S. Geological Survey drilled four test holes on the site in 1982; their locations are shown in fig. C-44. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 3.0	Topsoil, brown.
	3.0 - 5.0	Soil, tan.
	5.0 - 6.0	Clay, sandy, tan, damp.
	6.0 - 6.5	Same, but less sand and less damp.
	6.5 -11.5	Same, getting hard and brown, dry.
		SOIL SAMPLE: 5 - 6 ft.
2	0 - 1.5	Brown topsoil and fill.
	1.5 - 6.5	Same, fill material wet.
		WATER SAMPLE: 4.5 - 6.5 ft.
3	0 - 2.0	Demolition debris.
	2.0 - 6.5	Dark brown fill material.
	6.5 -11.5	Same, pulled up bit; black oil liquid on bit stem starting 2 ft below joint.
	11.5 -16.5	Black oily material.
		SOIL SAMPLE: 15 - 16 ft.
4	0 - 6.5	Brown topsoil and fill.
	6.5 - 11.5	Same, turning black at about 8 ft.
	11.5 - 16.5	Same, black oily materials on stems.
		SOIL SAMPLE: 8 - 11.5 ft.

Hydrologic information.--The Geological Survey installed one well on the site; its location is shown in fig. C-44. The direction of ground-water flow is probably southwestward toward the Little River. Pumping of the well during sampling caused little drawdown, indicating that the fill is highly permeable.

Chemical information.--The Geological Survey collected a water sample from the well and three soil samples for heavy-metals and organic-compound analyses; results are given in table C-24. Chromium, iron, and lead concentrations exceeded USEPA criteria for drinking water and the New York State ground-water standards; copper concentrations exceeded those in background soils. The only organic priority pollutant found was di-n-butyl phthalate, and that was at a concentration less than the quantifiable detection limit. Three organic nonpriority pollutants were found.

Table C-24.--Analyses of ground-water and substrate samples from Griffon Park, site 85, Niagara Falls, N.Y., July 12, 1982.
[Locations shown in fig. C-44. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit, blanks indicate inorganic constituent was not analyzed.]

	Sample number and depth below land surface (ft)				
	Substrate	Ground water	Substrates		
	1 (6.0)	2 (5.5)	3 (11.0)	3A (split)	4 (10.0)
pH		6.8			
Specific conductance (μmho/cm)		2,350			
Temperature (°C)		13.0			
Inorganic constituents					
Aluminum		781			
Antimony		--			
Arsenic		--			
Barium		1,220†			
Beryllium		--			
Cadmium		6			
Chromium		59†			
Cobalt		--			
Copper	8,000†	--	49,000††	(63,000)††	17,000
Iron	11,000,000†	48,500†	13,000,000	(21,000,000)	83,000,000
Lead		140†			
Manganese		730			
Mercury	--	1.3†	40	(40)	--
Nickel		62			
Selenium		--			
Silver		--			
Tellurium		--			
Vanadium		--			
Zinc		3,920			

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration is semiquantitative and based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water and New York State standard for maximum concentration in ground water.

†† Exceeds concentrations in samples taken from undisturbed soils in the Niagara Fall area. Undisturbed soils not analyzed for iron.

***Analyzed at detection limit above that required by this study. No compounds detected.

Table C-24.--Analyses of ground-water and substrate samples from Griffon Park, site 85, Niagara Falls, N.Y., July 12, 1982 (continued) [Locations shown in fig. C-45. Concentrations are in μg/L and μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit, blanks indicate inorganic constituent was not analyzed.]

	Sample number				
	Substrate	Ground water	Substrates		
	1	2	3	(Split)	4
Organic compounds	***		***	***	***
Priority pollutant					
Di-n-butyl phthalate		LT			
Nonpriority pollutants					
2-(2-Butoxyethoxy)-ethanol[1]		220			
4-(1,1-Dimethylethyl)-phenol[1]		36			
4-Nitrophenol		LT			

Electromagnetic survey.--The Geological Survey ran an electromagnetic survey of the site with three lines in November 1982. Their locations are shown in fig. C-45; the values are plotted in fig. C-45 (p. 388).

Line 1.--This line, along the bank of the Little River (fig. C-45) showed mostly background conductivity until 400 ft from the northern end of the line. From there southward, however, a considerable deviation is seen. The values become most erratic at the southern end of the line, near an adjacent hazardous-waste landfill (site 40).

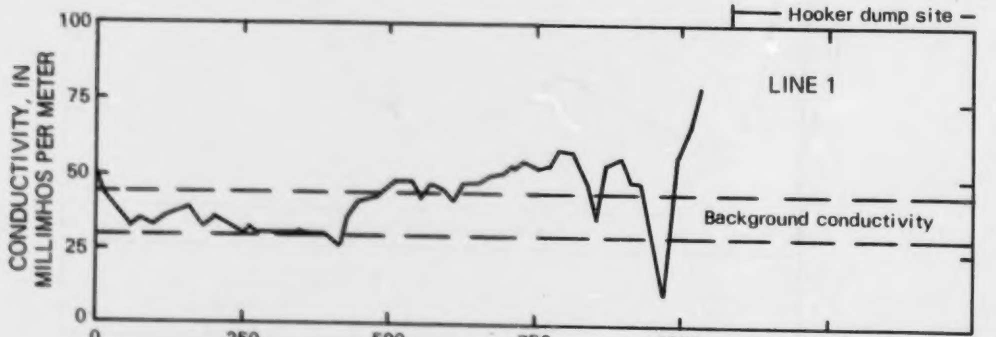


Figure C-44. Results of electromagnetic-conductivity survey at Griffon Park, site 85, Niagara Falls, line 1. (Locations of lines are shown in fig. 45.)

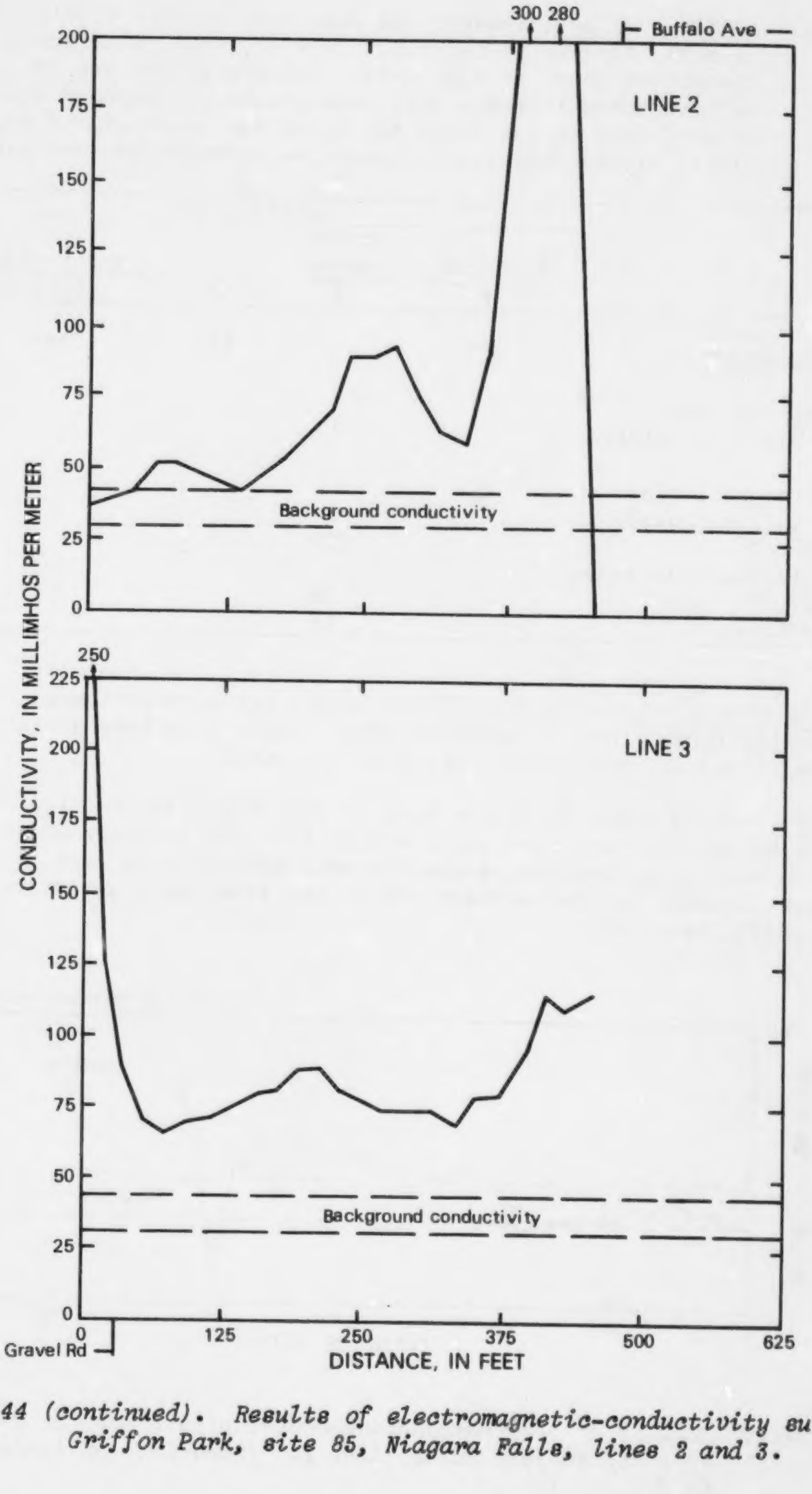
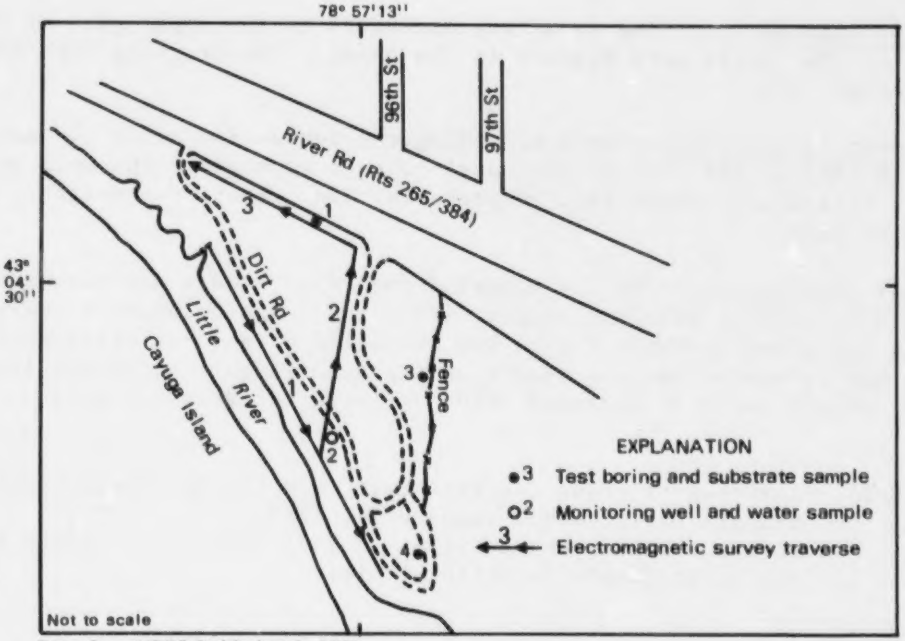


Figure C-44 (continued). Results of electromagnetic-conductivity survey at Griffon Park, site 85, Niagara Falls, lines 2 and 3.

Lines 2 and 3.--These lines show unnatural conductivity values throughout their length. The large conductivity rise and subsequent drop at the northern end of line 2 (fig. C-51) can probably be attributed to a large pipe below Buffalo Avenue. The width of the high-conductance area on line 2, however, indicates that the material below the gravel road is more conductive than the surrounding fill. The higher conductivity of material below the gravel road is also clearly shown in line 3 which parallels Buffalo Avenue.



Base from USGS field sketch, 1982

Figure C-45. Location of monitoring well, sampling holes, and electromagnetic-conductivity survey lines at Griffon Park, site 85, Niagara Falls.

86. HYDRAULIC CANAL (USGS field reconnaissance) NYSDEC 932082

General information and chemical-migration potential.--The Hydraulic Canal, in the city of Niagara Falls, was used to supply water to the Schoellkopf Power Generating Station before its collapse in the mid-1950's. Thereafter the canal was filled with domestic refuse, demolition material, and clean fill. It is not known whether industrial wastes were buried in the canal.

The potential for contaminant migration is indeterminable. No evidence of contaminant migration to the upper river has been reported, but additional monitoring would be needed to confirm this.

Geologic information.--The canal was excavated in the upper part of the Lockport Dolomite. Two wells were drilled in the canal. The drilling logs described the material as fill.

Hydrologic information.--The U.S. Geological Survey installed two monitoring wells in 1982 in the fill of the canal--one at each end. The well at the south end has filled with water that is probably river water; the northern well contained no water.

Chemical information.--The Geological Survey collected a water sample from the southern monitoring well for copper, iron, and organic-compound analyses; results are given in table C-25. Two volatile organic priority pollutants were found, but at concentrations less than the quantifiable detection limit. Neither copper nor iron exceeded USEPA criteria for drinking water.

Table C-25.--Analyses of ground-water sample from the Hydraulic Canal, site 86, Niagara Falls, N.Y., January 14, 1983.
[Concentrations are in µg/L; LT indicates it was found but below the quantifiable detection limit.]

Depth below land surface (ft)	14.5
pH	7.8
Specific conductance (µmho/cm)	288
Temperature (°C)	2.5
Inorganic constituents	
Copper	3
Iron	260
Organic compounds	
Priority pollutants	
Tetrachloroethane**	LT
1,1,2,2-Tetrachloroethane**	LT

** Volatile found in GC/MS extractions. Concentration probably higher than that detected.

87. NEW ROAD SITE (USGS field reconnaissance) NYSDEC 932083

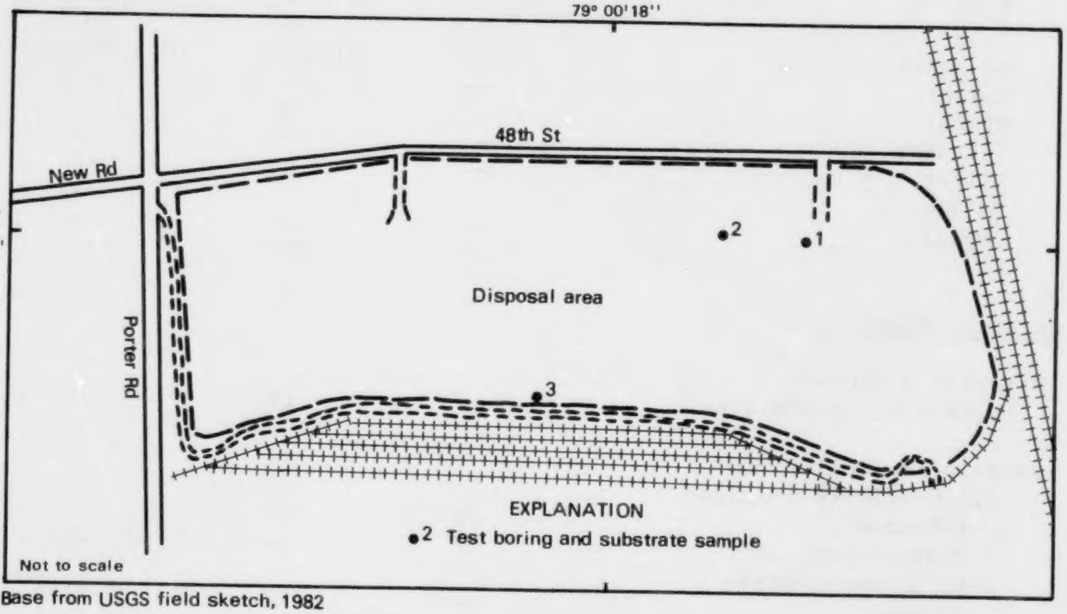
General information and chemical-migration potential.--The New Road site, in the city of Niagara Falls, was used to dispose of an unknown quantity of noncombustibles and incinerator residue. The site contains three monitoring wells (fig. C-46).

The potential for contaminant migration is indeterminable.

Geologic information.--The site is assumed to consist of a glacial ground moraine deposit overlying bedrock of Lockport Dolomite.

Hydrologic information.--The direction of regional ground-water flow is probably southward.

Chemical information.--The U.S. Geological Survey collected a water sample in 1982 from each monitoring well for heavy-metals and organic-compound analyses. Results are given in table C-26. Iron, lead, and maganese concentrations exceeded USEPA criteria for drinking water in all three samples; aluminium was much higher than normal. The only organic priority pollutant found was di-n-butyl phthalate (less than the quantifiable detection limit). Four organic nonpriority pollutants were found.



Base from USGS field sketch, 1982

Figure C-46. Location of monitoring wells at New Road, site 87, Niagara Falls

Table C-26.--Analyses of ground-water samples from New Road, site 87, Niagara Falls, N.Y., July 8, 1982.
[Locations shown in fig. C-46. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)		
	1 (20.3)	2 (14.3)	3 (15.8)
pH	6.7	7.0	7.0
Specific conductance (µmho/cm)	3,200	3,260	1,200
Temperature (°C)	12.0	12.0	12.0
Inorganic Constituents			
Aluminum	2,400	1,380	2,220
Antimony	--	--	--
Arsenic	--	--	--
Barium	974	382	454
Beryllium	--	--	--
Cadmium	7	9	13†
Chromium	23	58†	34
Cobalt	--	55	84
Copper	--	83	--
Iron	11,000†	41,900	13,000†
Lead	71†	66†	128†
Manganese	4,940†	1,640†	4,220†
Mercury	--	--	--
Nickel	--	68	77
Selenium	--	--	--
Silver	--	12	15
Tellurium	--	--	--
Vanadium	--	--	--
Zinc	269	209	316
Organic compounds			
Priority pollutant			
Di-n-butyl phthalate	--	LT	--
Nonpriority pollutants			
2,4,6-Trimethyl-1,3,5-trioxane[1]	26	--	--
2-Ethyl-1-hexanol[1]	17	--	--
2-(2-Butoxyethoxy)-ethanol[1]	--	150	--
1,3-Dimethylbenzene[1]	--	--	26

---

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

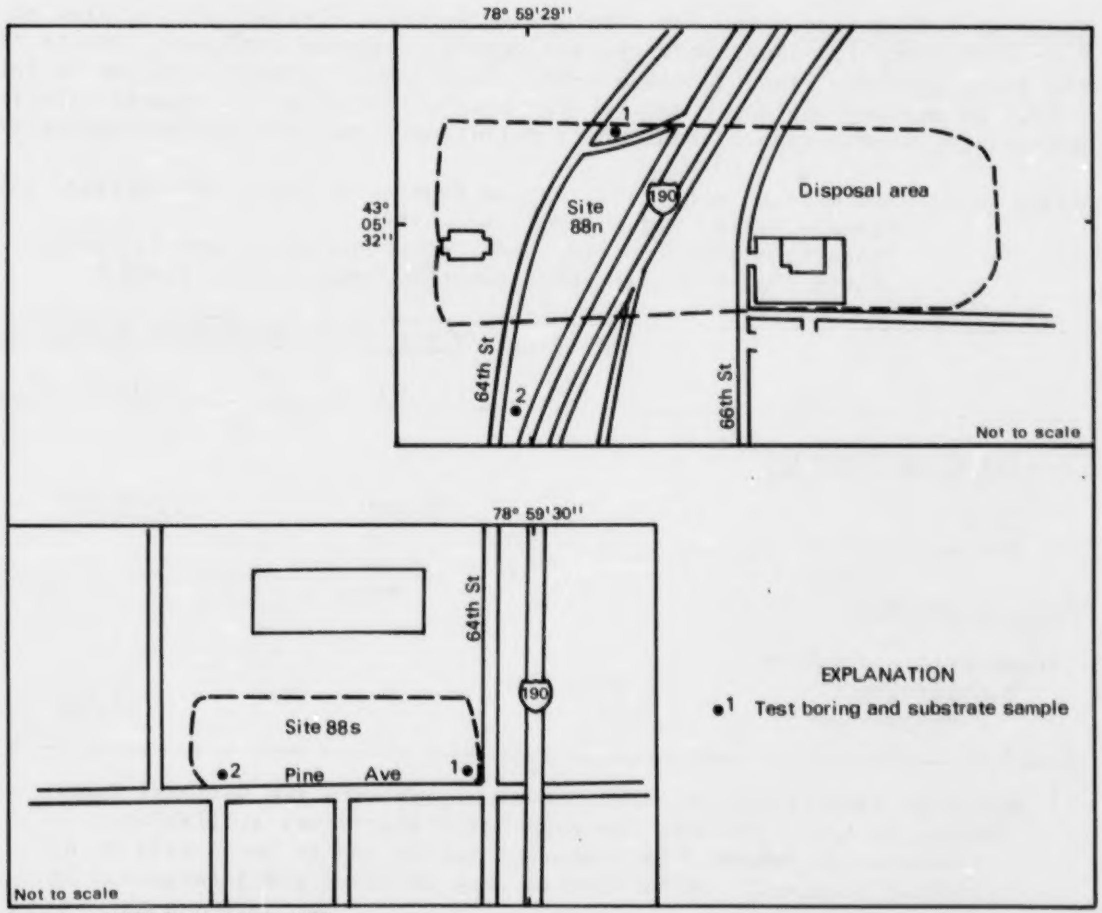
† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

88. 64TH STREET SITE (USGS field reconnaissance) NYSDEC 932085

General information and chemical-migration potential.--The 64th Street site, in the city of Niagara Falls, was used by the city to dispose of an unknown quantity of garbage and refuse. Industrial waste may also have been buried. The site consists of a north and a south area.

The potential for contaminant migration at this site is indeterminable. Preliminary chemical data suggest that migration is not taking place, but additional sampling would be needed to confirm this.

Geologic information.--The site consists of a clay unit interbedded with sand stringers overlying bedrock of Lockport Dolomite. In 1982 the U.S. Geological Survey drilled two test borings in the southern part of the site (fig. C-47), and two auger holes in the northern part. The geologic logs of the southern part of the site are on page 394; the auger holes at the northern part of the site both encountered fill overlying the clay within 2 ft of land surface.



Base from USGS field sketch, 1982

Figure C-47. Location of sampling holes at 64th Street, site 88, Niagara Falls.

Boring no.	Depth (ft)	Description
1	0 - 2.0	Topsoil.
	2.0 - 3.5	Clay, sandy, dry.
	3.5 - 5.0	Sand, yellow brown, wet.
	5.0 - 6.0	Clay, red. SAMPLE: 5 ft.
2	0 - 2.0	Topsoil.
	2.0 - 3.5	Sand, fine, dry.
	3.5 - 5.0	Clay, sandy, yellow.
	5.0 - 6.0	Sand, fine, wet.
	6.0 - 6.5	Clay, red. SAMPLE: 3.5 ft.

Hydrologic information.--Ground water was encountered in both test holes in the southern part of the site at a depth of approximately 6 ft, but no water was encountered in the northern test holes.

Chemical information.--The U.S. Geological Survey collected soil samples at all four test holes for iron, mercury, and organic-compound analyses; results from the south site are given in table C-27, those from the north site are in table C-28. No mercury was detected, but the samples contained 13 organic priority pollutants, seven organic nonpriority pollutants, and some unknown hydrocarbons.

Table C-27.--Analyses of substrate samples from south site, 64th Street, site 88, Niagara Falls, N.Y., August 11, 1982.
[Locations shown in fig. C-47. Concentrations are in μg/kg; dashes indicate that constituent or compound not found.]

	Sample number and depth below land surface (ft)	
	1 (5.0)	2 (3.5)
Inorganic constituents		
Iron	33,000	1,300,000
Mercury	--	--
Organic compound	***	
Nonpriority pollutant		
N,N-Dimethyl-1-dodecanamine	--	12,000

---

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

***Sample analyzed at detection limit above that required by this study. No compounds detected.

Table C-28.--Analyses of substrate samples from north site, 64th Street, site 88, Niagara Falls, N.Y.

[Locations shown in fig. C-47. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found.]

	Sample number and depth below land surface (ft)	
First sampling (07-02-82)	1 (3.3)	2 (2.7)
Inorganic constituents		
Iron	4,200,000	2,600,000
Mercury	--	--

	Sample number	
Second sampling (05-29-83)	1A	2A
Inorganic constituent		
Molecular sulfur[1]	*	--
Organic compounds		
Priority pollutants		
Acenaphthene	*	--
Fluoranthene	* **	--
Naphthalene	*	--
N-nitrosodidiphenylamine	*	--
Benzo(a)anthracene	* **	*
Benzo(a)pyrene	* **	*
Benzo(b)fluoranthene and benzo(k)fluoranthene	* **	--
Chrysene	--	*
Benzo(ghi)perylene	* **	--
Fluorene	*	--
Phenanthrene	* **	--
Indeno(1,2,3-cd)pyrene	* **	*
Pyrene	* **	--
Nonpriority pollutants		
Benzoic acid	*	--
Dibenzofuran	*	--
2-Methylnaphthalene	*	--
Benzaldehyde[1]	*	--
Trans-1,2-dichlorocyclohexane[1]	*	--
O-anilinephenyl-thiocyanate[1]	*	--
Unknown hydrocarbons[1]	*	*

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base neutral-extractable compounds were extracted.

** Surrogate recoveries were outside the acceptance limits.

89. WHIRLPOOL SITE (USGS field reconnaissance) NYSDEC 932088

General information and chemical-migration potential.--The Whirlpool site, along the Niagara River north of the Whirlpool Bridge, was used by the City of Niagara Falls to dispose of an unknown quantity of street sweepings and leaves. Some domestic refuse may have been deposited at the site before 1940.

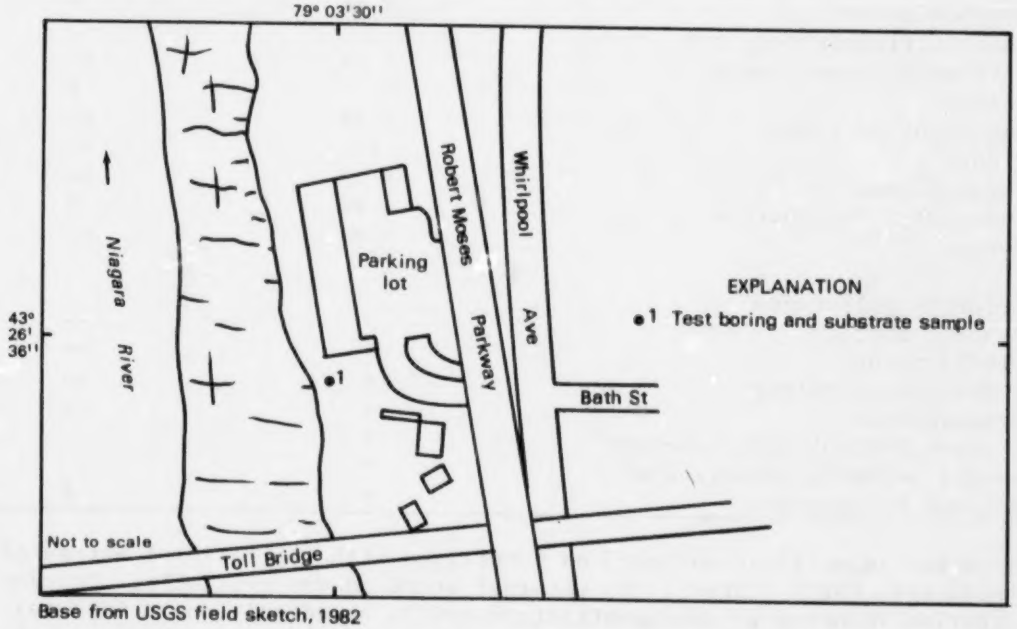
The potential of ground-water contaminant migration is indeterminable. The one soil sample gave no evidence of contamination, but additional data would be needed to confirm this.

Geologic information.--The U.S. Geological Survey drilled one test boring on the site in 1982; the location is shown in figure C-48. The geologic log is as follows:

Boring no.	Depth (ft)	Description
1	0 - 3.0	Fill and topsoil
	3.0 - 9.0	Clay, tan, sandy fill.
	9.0	Dolomite.
		SAMPLE: 8.75 ft.

Hydrologic information.--No ground water was encountered. If ground water is present, it is probably restricted to fractures in the underlying bedrock.

Chemical information.--The soil sample was analyzed for organic compounds. No organic compounds were detected.



Base from USGS field sketch, 1982

Figure C-48. Location of sampling hole at Whirlpool, site 89, Niagara Falls.

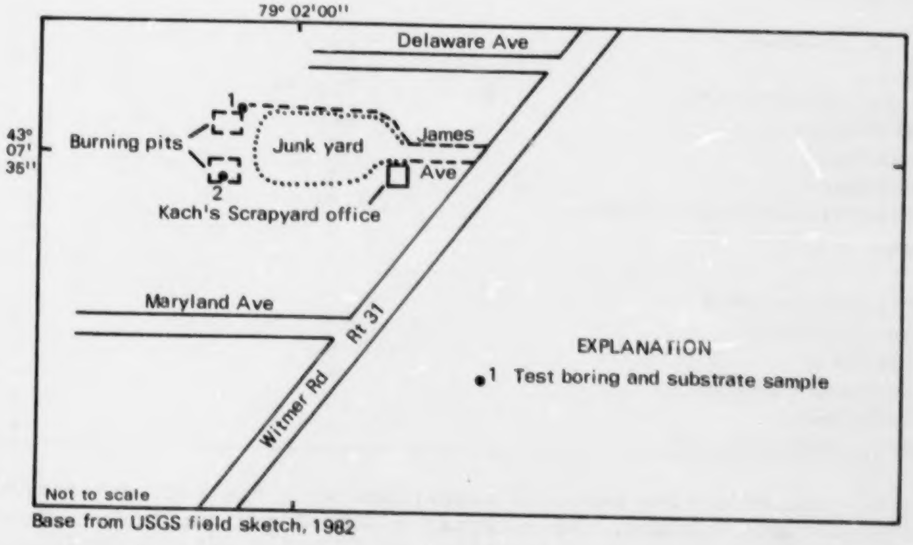
90. WITMER ROAD SITE (USGS field reconnaissance) NYSDEC 932027

General information and chemical-migration potential.--The Witmer Road site, in the town of Niagara, contains an unknown quantity of incinerator residue. The site is now a scrapyard. The potential for contaminant migration is indeterminable.

Geologic information.--The Geological Survey drilled two test borings on the site in 1982; locations are shown in fig. C-49. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 6.5	Black topsoil, reddish, sand clay at bottom.
	6.5 - 7.0	Clay, sandy, reddish.
	7.0 - 8.7	Split spoon - sand, red, some yellow particles, ashes.
	8.7 - 9.0	Split spoon--Sand, red, some yellow particles, and ash at 9.0 ft.
		SAMPLE: 7.0 ft.
2	0 - 4.0	Topsoil.
	4.0 - 7.5	Limestone (dolomite), light gray, ash.
	7.5 - 10.0	Sand, reddish, clayey.
		SAMPLE: 6.5 ft.

Hydrologic information.--No ground water was encountered; it is probably confined to the fractured bedrock.



Base from USGS field sketch, 1982

Figure C-49. Location of sampling holes at Witmer Road, site 90, Niagara Falls.

Chemical information.--The U.S. Geological Survey collected two soil samples for copper, iron, mercury, and organic-compound analyses. The results are given in table C-29. The concentration of copper in sample 2 exceeded concentrations in samples from undisturbed sites not affected by waste-disposal practices. The samples contained seven organic priority pollutants, five organic nonpriority pollutants, and some unknown hydrocarbons.

Table C-29.--Analyses of substrate samples from Witmer Road, site 90, Niagara Falls, N.Y.
[Locations shown in fig. C-49. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)	
First sampling (06-29-82)	1	2 (6.5)
Inorganic constituents		
Copper	2,000	28,000
Iron	1,200,000	1,400,000
Mercury	--	--

	Sample number	
Second sampling (05-25-83)	1A	2A
Inorganic constituent		
Molecular sulfur[1]	--	450
Organic compounds		
Priority pollutants		
Benzene	--	8.8
1,1,1-Trichloroethane	22.9**	--
Trichloroethene	LT	--
Fluoranthene	*	--
Naphthalene	*	--
Bis(2-ethylhexyl) phthalate	* **	--
Pyrene	*	--
Nonpriority pollutants		
Carbon disulfide	--	38.4
Dibenzofuran	*	--
2-Methylnaphthalene	*	--
2-Octadecanol[1]	--	*
Unknown hydrocarbons[1]	*	*

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified; holding time exceeded before GC/MS acid- and base neutral-extractable compounds were extracted.

** Surrogate recoveries were outside the acceptance limits.

91. TOWN OF NIAGARA, LOCKPORT ROAD LANDFILL (Literature review) NYSDEC 932089

General information and chemical-migration potential.--The Lockport Road landfill, in the city of Niagara Falls, has been used mainly for residential waste such as paper, glass, yard trimmings, metal, rags, plastics, garbage, and miscellaneous items.

Preliminary geologic and chemical data indicate a limited potential for contaminant migration; however, the potential is indeterminable at this time. The underlying silty clay may prevent vertical flow of contaminants to the fractured bedrock. Periodic water-quality monitoring at wells on the site would be needed to detect lateral migration of leachate from the site.

Geologic information.--The site consists of a lacustrine silty clay about 13 ft thick overlying bedrock of Lockport Dolomite (Wegman Co., Inc., 1978).

Hydrologic information.--Dunn Geoscience Corp. installed three monitoring wells, one upgradient and two downgradient from the landfill. Ground water was encountered from 3 to 7 ft below grade. Ground-water flow is probably westward toward Gill Creek.

Chemical information.--A water sample was taken from each monitoring well for heavy-metals analysis. Results indicated slightly elevated concentrations of all heavy metals except iron, which was as high as 530 µg/L.

Sources of data

Dunn Geoscience Corporation, 1981, Town of Niagara Sanitary Landfill, Facility No. 32S08, open dump inventory, ground-water quality evaluation, New York State Department of Environmental Conservation Resource Conservation Recovery Act: Albany, N.Y., Dunn Geoscience Corp., 16 p., 4 appendices, 1 map.

Leonard S. Wegman Co., Inc., 1978, Sanitary landfill report, Town of Niagara: 50 p., 4 appendices.

92. NIAGARA FRONTIER TRANSPORTATION AUTHORITY (USGS field reconnaissance) NYSDEC 932090

General information and chemical-migration potential.--The Niagara Frontier Transportation Authority site, in the town of Wheatfield, is a basin that has collected an unknown amount of phenolic spills from the adjacent abrasive plant.

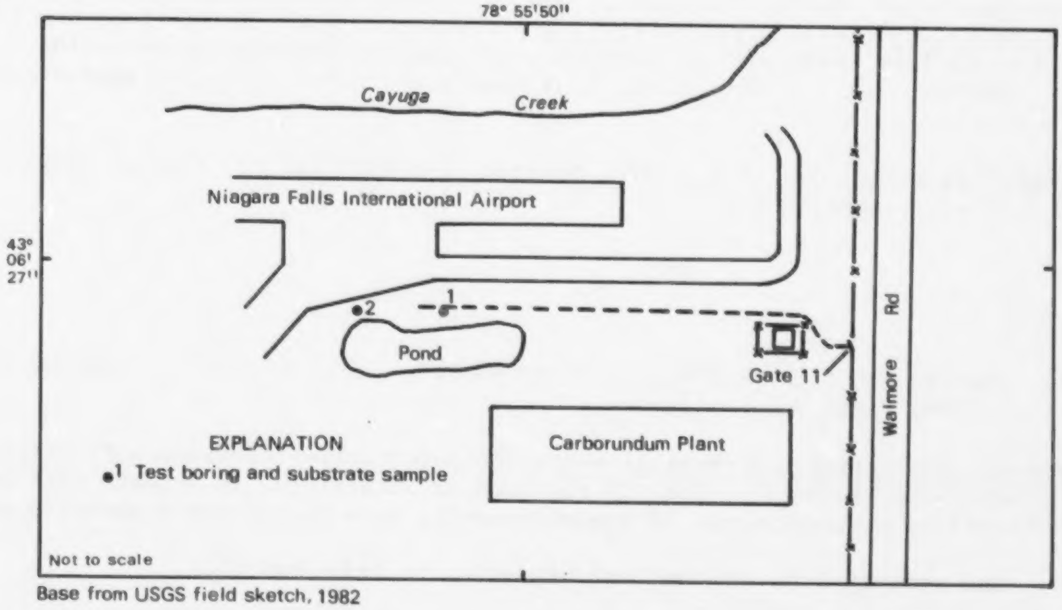
The potential for contaminant migration is indeterminable.

Geologic information.--The site consists of unconsolidated deposits probably overlying Lockport bedrock. The U.S. Geological Survey drilled two boreholes on the site in 1982; the locations are shown in figure C-50. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 3	Topsoil, brown.
	3 - 5.5	Clay, sandy, brown, tight.
	5.5 - 6.5	Clay, reddish, tight.
	6.5 - 8.0	Same.
	8.0 - 13.0	Same.
	13.0 - 15.0	Clay, reddish, wet, with some small gravel. SAMPLE: 13 - 15 ft.
2	0 - 3.5	Topsoil, brown.
	3.5 - 7.5	Clay, pinkish brown.
	7.5 - 10.0	Same, changing to greenish gray.
	10.0 - 15.0	Clay, pinkish, wet. SAMPLE: 14 - 15 ft.

Hydrologic information.--Ground water was encountered from 10 to 13 ft below land surface. The yield from the saturated zone was too low to warrant the installation of monitoring wells. The direction of ground-water flow is probably northward toward Cayuga Creek.

Chemical information.--The U.S. Geological Survey collected two soil samples for organic-compound analyses; results are given in table C-30. The samples contained three priority pollutants, all phthalates and all below 40 µg/kg, and two nonpriority pollutants.



Base from USGS field sketch, 1982

Figure C-50. Location of sampling holes at Niagara Frontier Transportation Authority, site 92, Niagara Falls.

Table C-30.--Analyses of substrate samples from Niagara Frontier Transportation Authority, site 92, Wheatfield, N.Y., July 27, 1982. [Locations shown in fig. C-50. Concentrations are in µg/kg, dashes indicate that compound was not found.]

	Sample number	
	1A	2A
Organic compounds		
Priority pollutants		
Bis(2-ethylhexyl) phthalate	35.7	--
Di-n-octyl phthalate	15.8	--
Diethyl phthalate	LT	--
Non-priority pollutants		
Acetone	38.1	--
Bis(2-ethylbutyl) phthalate[1]	570	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

94. NIAGARA RIVER--BELDEN SITE (USGS field reconnaissance) NYSDEC 932055

General information and chemical-migration potential.--The Belden site, on the Niagara River in the town of Wheatfield, was used by the Goodyear Company for the deposition of fill, rubble, and thiazole polymer blends in unknown quantities. Leachate has been noted leaving this site in surface water, but the chemical composition is unknown.

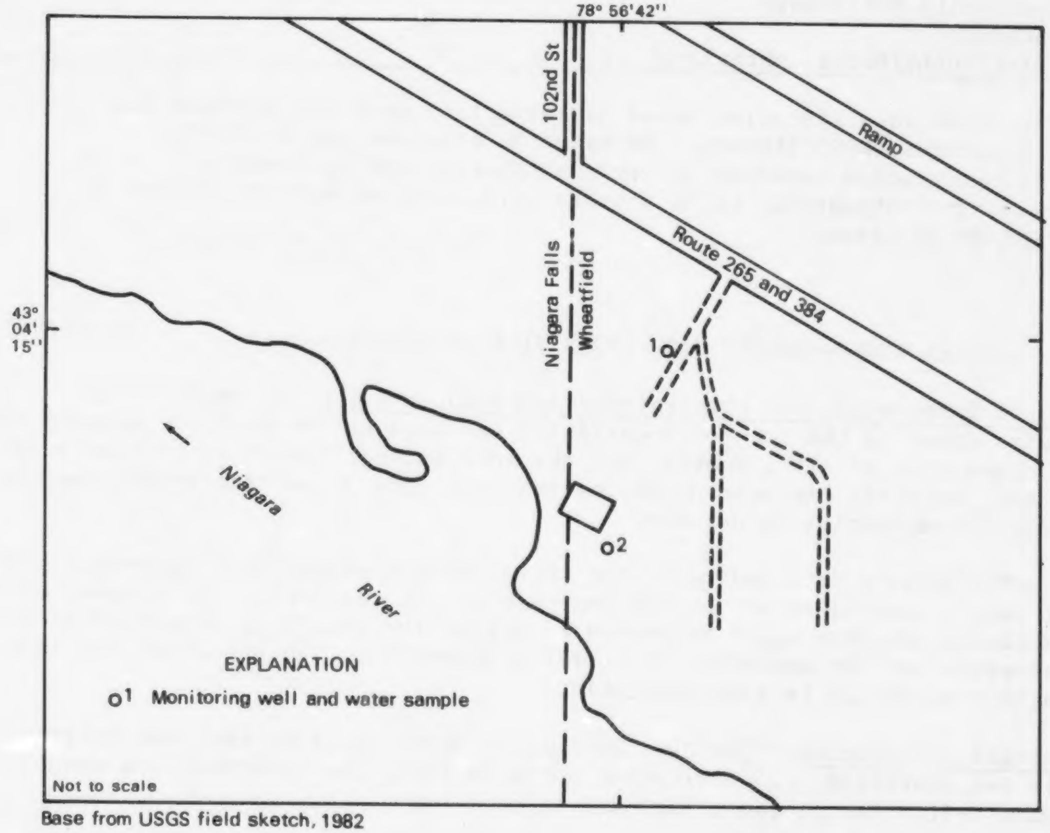
Preliminary data indicate some potential for contaminant migration, but the analyses of ground-water samples indicate low concentrations of contaminants. Additional analyses would be needed to define the extent of ground-water contamination and the potential for offsite migration. The potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled two test holes on the site and installed two monitoring wells in 1982; the locations are shown it figure C-51. The geologic logs are on page 402.

Hydrologic information.--Ground water was encountered in both test holes. The direction of ground-water flow is probably southwestward toward the river.

Chemical information.--A water sample was collected from each of the monitoring wells and analyzed for organic compounds; results are given in table C-31. The samples contained two priority pollutants, both phthalates, at concentrations below the quantifiable detection limit, and four nonpriority pollutants as well as two possibly naturally occurring organic compounds.

Boring no.	Depth (ft)	Description
1	0 - 2.6	Black, wet, organic material.
	2.6 - 3.0	Clay, water running into hole from black material above.
		WATER SAMPLE: 2 - 3.7 ft.
2	0 - 3.7	Topsoil.
	3.7 - 4.0	Clay, very sandy, buff-colored particles.
	4.0 - 5.0	Clay, some sand, dark, gray.
	5.0 - 5.7	Sand, medium, grayish, wet.
		WATER SAMPLES: 2 - 4 ft.



Base from USGS field sketch, 1982

Figure C-51. Location of monitoring wells at Niagara River-Belden site, site 94, Wheatfield.

Table C-31.--Analyses of ground-water samples from Niagara River--Belden site, site 94, Wheatfield, N.Y., June 26, 1982.
[Locations shown in fig. C-51. Concentrations are in µg/L; dashes indicate that compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft) 1 (3.7)	2 (4.2)
pH	7.4	7.0
Specific conductance (µmho/cm)	2,080	1,200
Temperature (°C)	16.5	13.5
Organic compounds		
Priority pollutants		
Dimethyl phthalate	LT	--
Nonpriority pollutants		
Diethyl phthalate	LT	LT
1,8-Naphthalene dimethano[1]	5.8	--
N-(1,1-Dimethylethyl)-4-methylbenzamide[1]	18.6	12
1,1'-oxybisbutane[1]	--	34
2-hydroxy-propanoic acid, butylester[1]	--	18
Compounds potentially of natural origin		
3-methylbutanoic acid [1]	--	LT
1,7,7-Trimethylbibyclo [2.2.1]heptan-2-one(camphor)[1]	LT	LT

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

95. OLD CREEK BED (DiBacco no. 1) SITE NYSDEC 932056-a
(USGS field reconnaissance)

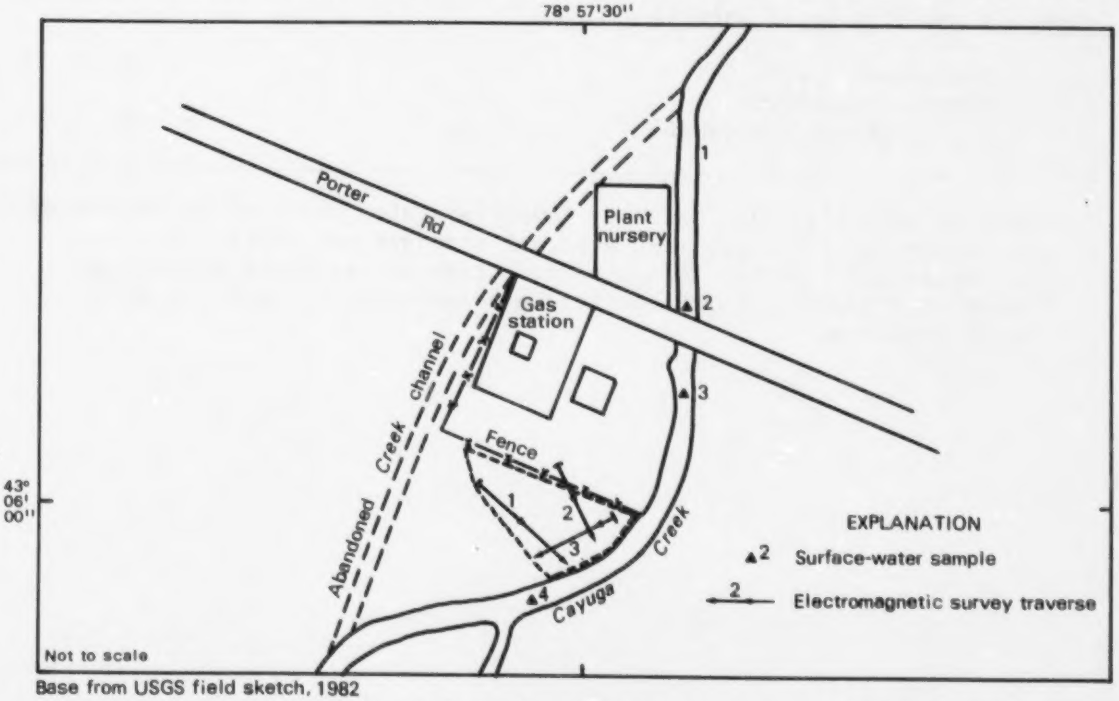
General information and chemical-migration potential.--This site, in the town of Niagara, has been used to dispose of fill containing rocks, broken concrete, and inert wastes from an abrasives-plant warehouse that was destroyed by fire in 1977. A chemical firm indicated that hexachlorocyclopentadiene catalyst may be buried there also. A sketch of the site is shown in figure C-52.

Although contaminant migration into Cayuga Creek seems possible because the fill material is in contact with the creek, the preliminary chemical data suggest that the potential for contaminant migration is limited. Future monitoring would be necessary to confirm the migration potential. (At present it is indeterminable.)

Geologic information.--The site consists of a lacustrine clay deposit overlying bedrock of Lockport Dolomite. No test holes could be drilled on the site because the fill was too rocky.

Hydrologic information.--No ground water was obtained, but topographic relief suggests that ground water flows southeastward toward Cayuga Creek.

Chemical information.--The Geological Survey collected four water samples from Cayuga Creek, next to the site, in 1982; locations are shown in figure C-52. Each sample was analyzed for copper, iron, lead, mercury, and organic compounds; results are given in table C-32. Lead exceeded the USEPA criterion for drinking water and the New York State ground-water standard. Sample 2 contained one organic priority pollutant; four organic nonpriority pollutants also were found.



Base from USGS field sketch, 1982

Figure C-52. Location of surface-water samples and electromagnetic-conductivity survey at Old Creek Bed (Dibacco no. 1), site 95, Niagara.

Table C-32.--Analyses of surface-water samples from Old Creek Bed (Dibacco), site 95, Niagara Falls, N.Y., July 9, 1982.
[Locations shown in fig. C-52. Concentrations are in µg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number			
	1	2	3	4
pH	7.7	7.8	7.8	7.8
Specific conductance (µmho/cm)	1,670	1,480	1,670	1,630
Temperature (°C)	22.0	23.0	23.0	23.0
Inorganic Constituents				
Aluminum	260	281	276	311
Antimony	--	--	--	--
Arsenic	--	--	--	--
Barium	648	234	772	811
Beryllium	--	--	--	--
Cadmium	5	5	6	6
Chromium	20	22	20	21
Cobalt	--	--	--	--
Copper	--	--	--	--
Iron	463†	324†	312†	398†
Lead	14	10	--	21
Manganese	69	63	66	73
Mercury	--	--	--	--
Nickel	--	--	--	--
Selenium	--	--	--	--
Silver	--	--	--	--
Tellurium	--	--	--	--
Vanadium	--	--	--	--
Zinc	76	64	64	65
Organic compounds				
Priority pollutant				
Bis(2-ethylhexyl) phthalate	--	94	--	--
Nonpriority pollutants				
Diphenylamine	LT	LT	--	--
Heptanal[1]	--	8.8	--	--
2,3-Dichloro-2-methyl-butane	--	7.5	--	--
1,3-Dimethylbenzene[1]	--	20	--	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

Electromagnetic survey.--The U.S. Geological Survey conducted an electromagnetic survey with three survey lines on the site. Locations are shown in figure C-52; the values are plotted in fig. C-53.

Line 1.--The high conductivity value at the northern end of line 1 is probably related to the proximity of Roberts and Disney Roads. The next 200 ft were run in the open field next to Roberts Road. Though fairly uniform, the relatively high conductivities in this area indicate artificial fill. This conclusion is supported by map 28 of the New York State Museum and Science Service (Muller, 1977), which indicates this site to be in the same deposit as the Niagara County Refuse Disposal site (site 81). If this is correct, background conductivity values should be considerably lower than those in the vicinity of the open field near Roberts Road.

Line 2.--Beyond the open field crossed by lines 1 and 2 is a mound of fill. Conductivity values along both lines were considerably higher near the fill than elsewhere. Line 2 showed the more dramatic fluctuations, which suggests buried metallic refuse within the mounds. All readings taken along the present bank of Cayuga Creek were between 15 and 20 mmho/m, which is probably the local background range.

Line 3.--Line 3 was run mostly over visible refuse and showed the irregular elevated values that might be expected from undifferentiated waste material.

Source of data.--Muller, E. H., 1977, Quaternary geology of New York, Niagara Sheet: New York State Museum and Science Service, Map and Chart Series, no. 28, 1 sheet.

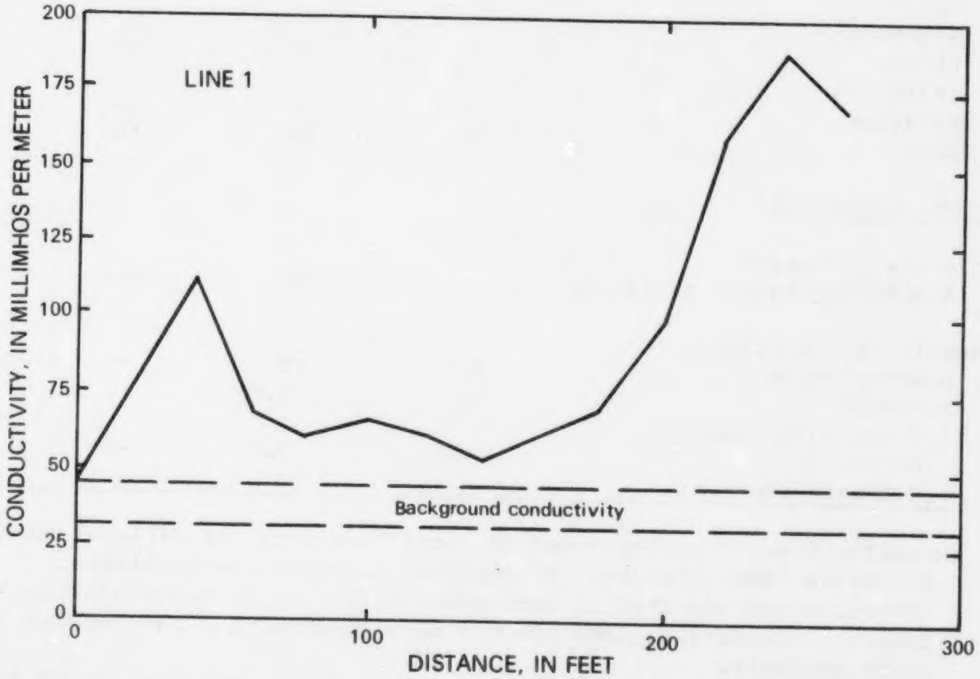

Figure C-53. Results of electromagnetic-conductivity survey at Old Creek Bed (Dibacco no. 1), site 95, Niagara, line 1.

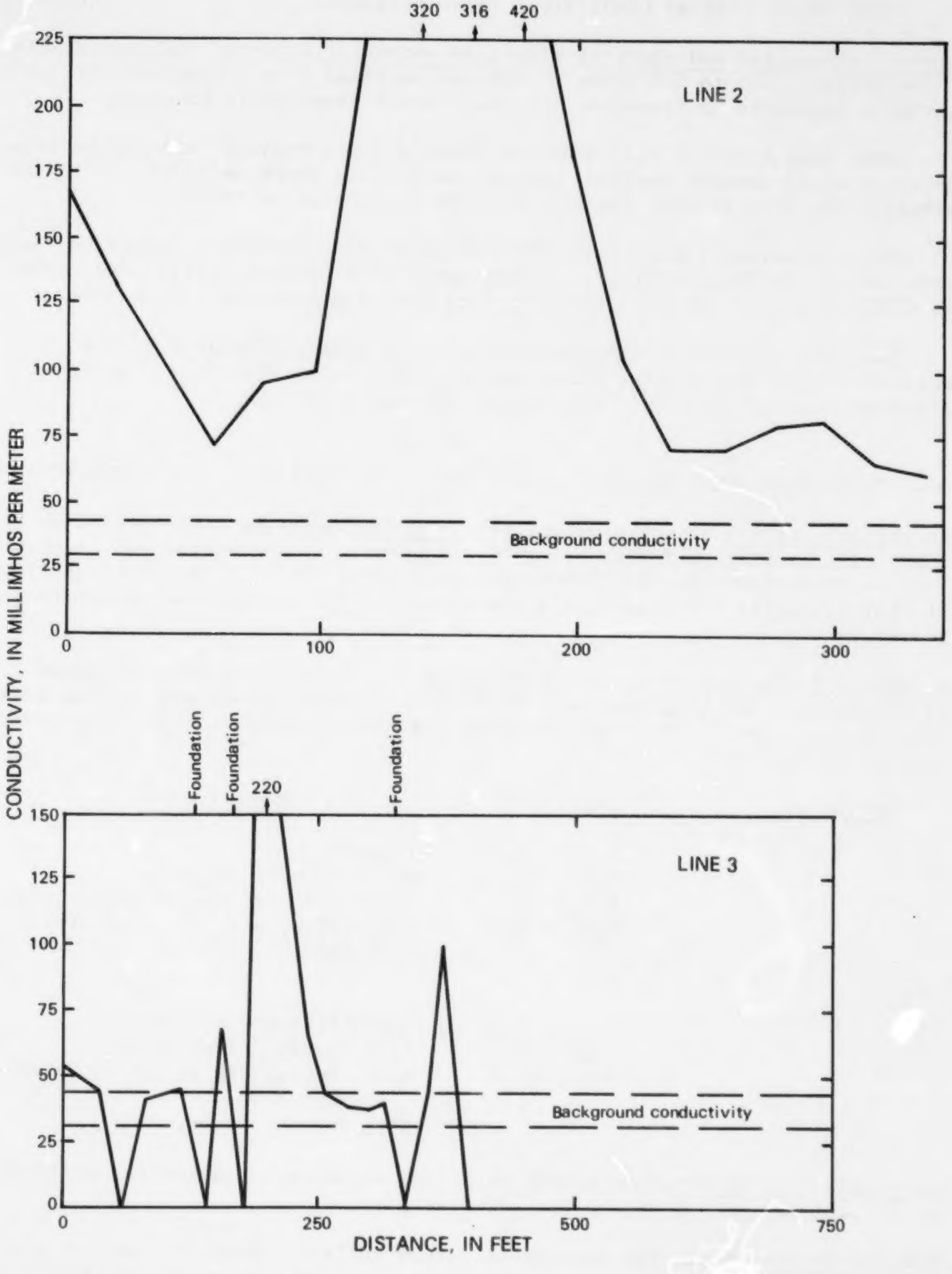

Figure C-53 (continued). Results of electromagnetic-conductivity survey at Old Creek Bed (Dibacco no. 1), site 95, Niagara, lines 2 and 3.

96. ROBERT MOSES PARKWAY (USGS field reconnaissance) NYSDEC 932067

General information and chemical-migration potential.--During the construction of the parkway, 200 to 300 drums of unknown material from a chemical firm were allegedly deposited in trenches, but their exact location is unknown.

Large quantities of fill from the Niagara Power Project excavations were deposited along several hundred feet of the Niagara river bed adjacent to the Parkway. The fill is more than 20 ft thick in several locations.

The high permeability of the fill suggests some potential for contaminant migration to the Niagara River. Contaminants from the industrial area bordering the northern end of the fill could migrate into the area and to the river.

The potential for contaminant migration is indeterminable from the available data. The general direction of ground-water flow in the unconsolidated material is toward the Niagara River.

100. SILBERGELD JUNK YARD (USGS field reconnaissance) NYSDEC 932093

General information and chemical-migration potential.--The Silbergeld Junk Yard, in the city of Niagara Falls, received scrap metal from chemical and electrochemical firms from the mid-1930's through the mid-1950's. The total quanity of material deposited is unknown, and the potential for contaminant migration is indeterminable.

Geologic information.--The site consists of a thin layer of unconsolidated deposits overlying Lockport Dolomite. The U.S. Geological Survey drilled two test holes on the site in 1982; the locations are shown in figure C-54. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 3.0	Topsoil.
	3.0 - 4.0	Black organic material.
	4.0 - 6.5	Clay, light at top to darker pink.
	6.5 - 8.5	Clay, pink, dry, hit rock at 8.5 ft. SOIL SAMPLE: 8.5 ft.
2	0 - 2.5	Topsoil, black, organic.
	2.6 - 6.5	Clay, sandy, ocher in color
	6.5 -10.0	Same, hit gravel at 9.0 ft. bedrock at 10.0 ft. SOIL SAMPLE: 9 ft.

Hydrologic information.--No ground water was encountered during the drilling, but it probably occurs in the bedrock fractures.

Chemical information.--The Geological Survey collected two soil samples for iron, mercury, and organic-compound analyses; results are given in table C-33. No mercury or organic compounds were detected.

Table C-33.--Analyses of substrate samples from Silbergeld Junk Yard, site 100, Niagara Falls, N.Y., July 8, 1982.
[Locations shown in fig. C-54. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)	
First sampling (07-08-82)	1 (8.5)	2
Inorganic constituents		
Iron	2,400,000	1,400,000
Mercury	--	--
	Sample number and depth below land surface (ft)	
Second sampling (05-27-83)	1A 3.0	2A 2.5
Inorganic constituent		
Molecular sulfur[1]	2,000	--
Organic compounds	--	--

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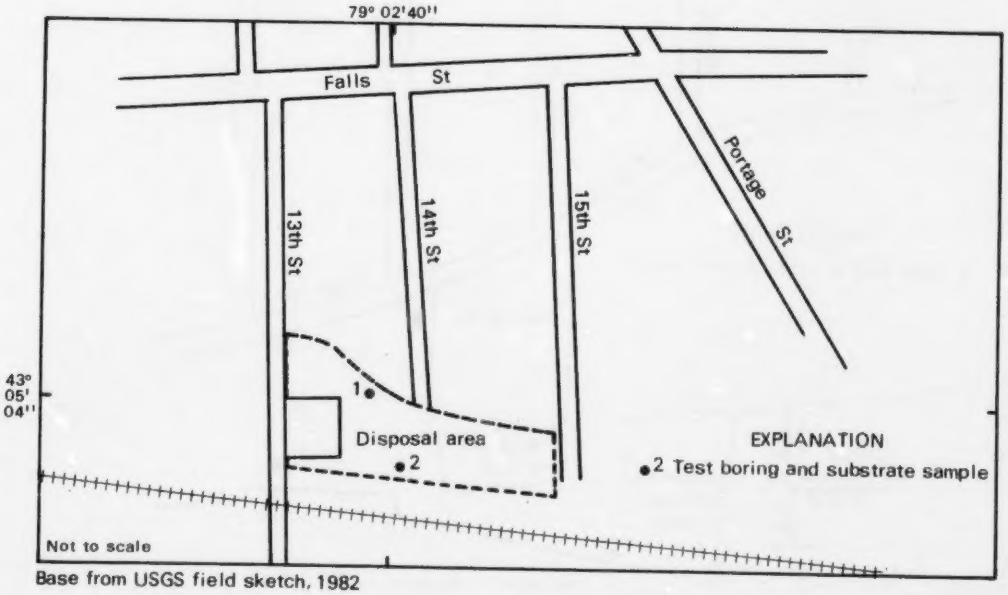
[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.



Base from USGS field sketch, 1982

Figure C-54. Location of sampling holes at Silbergeld Junk Yard, site 100, Niagara Falls.

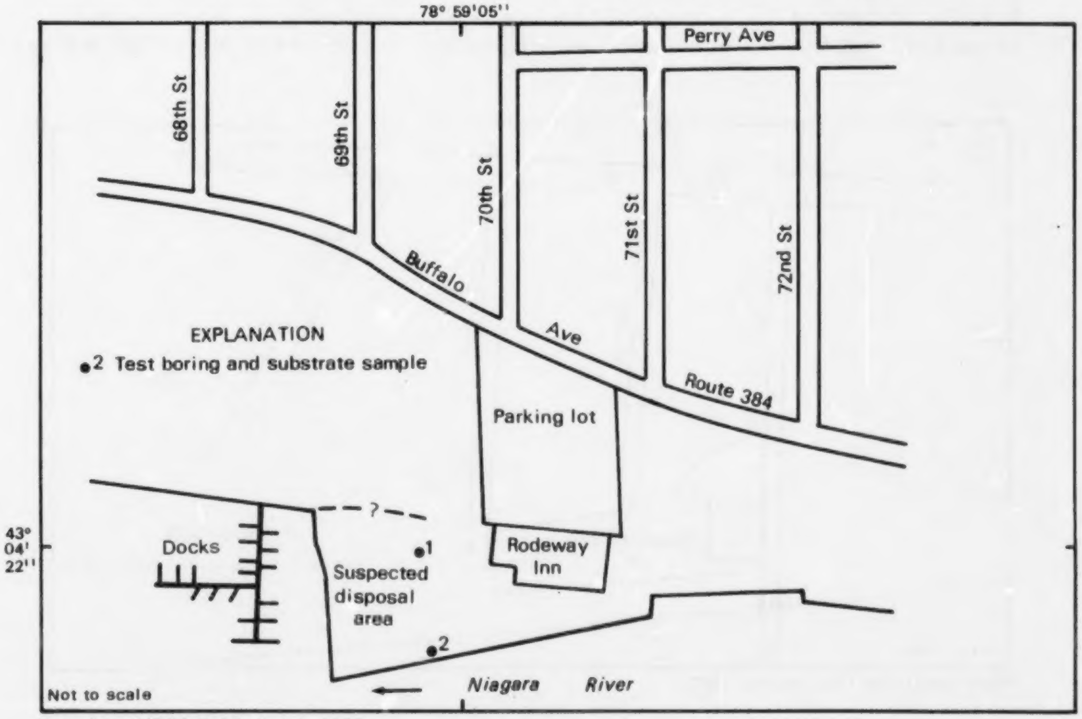
237. RODEWAY INN (USGS field reconnaissance) NYSDEC 932086

General information and chemical-migration potential.--The Rodeway Inn site, on the Niagara River in the city of Niagara Falls, was used to dispose of an unknown quantity of broken concrete from the Olin Corporation and incinerator residue.

The geology and proximity to the river indicate a limited potential for contaminant migration, but the chemical data are insufficient to evaluate whether ground-water contamination has occurred. Additional data would be needed to evaluate the water quality and the likelihood of contaminant migration. The potential is indeterminable.

Geologic information.--The Geological survey drilled two test borings on the site in 1982; locations are shown in figure C-55. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 5.0	Topsoil, black, some clay.
	5 - 6.5	Clay, sandy, with gravel, tan.
	6.5 - 7.5	Same, hit slag or bedrock. SOIL SAMPLE: 7.5 ft.
2	0 - 3.5	Tar surface and topsoil.
	3.5 - 5.0	Material looks like incinerator ash, wet SOIL SAMPLE: 5 ft.



Base from USGS field sketch, 1982

Figure C-55. Location of sampling holes at Rodeway Inn, site 237, Niagara Falls.

Hydrologic information.--Ground water was encountered in the test hole closest to the river (no. 2), but water was insufficient for installation of monitoring well. The direction of ground-water flow is probably southward toward the river.

Chemical information.--The U.S. Geological Survey collected two soil samples for iron, mercury, and organic-compound analyses; results are given in table C-34. Sample 2A contained five organic priority pollutants, but at concentrations less than the quantifiable detection limit. Two nonpriority pollutants and some unidentified hydrocarbons also were found.

Table C-34.--Analyses of substrate samples from Rodeway Inn, site 237, Niagara Falls, N.Y.
[Locations shown in fig. C-55. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)	
	1	2
First sampling (06-29-82)	(5.0)	(2.5)
Inorganic constituents		
Iron	5,000,000	30,000,000
Mercury	10	50
	Sample number and depth below land surface (ft)	
	1A	2A
Second sampling (05-29-83)	(5.0)	(2.5)
Inorganic constituent		
Molecular sulfur(S8)[1]	--	10,000
Organic compounds		
Priority pollutants		
Fluoranthene	--	LT
Bis(2-ethylhexyl) phthalate	--	LT
Benzo(a)anthracene	--	LT
Chrysene	--	LT
Phenanthrene	--	LT
Nonpriority pollutants		
Carbon disulfide	LT	--
Terpene[1]	--	2,000
Hydrocarbons[1]	--	17,000

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

238. SAINT MARY'S SCHOOL (USGS field reconnaissance) NYSDEC 932087

General information and chemical-migration potential.--The St. Mary's School site, in the city of Niagara Falls, received an unknown quantity of fly ash from Occidental Chemical Company during the 1950's. The potential for contaminant migration is indeterminable.

Geologic information.--The U.S. Geological Survey drilled three test borings on the site in 1982; the locations are shown in fig. C-56. The geologic logs are on page 413.

Hydrologic information.--Ground water was encountered in some of the sand units. The logs indicated a series of perched water-bearing units that may be caused by seasonal increases in precipitation.

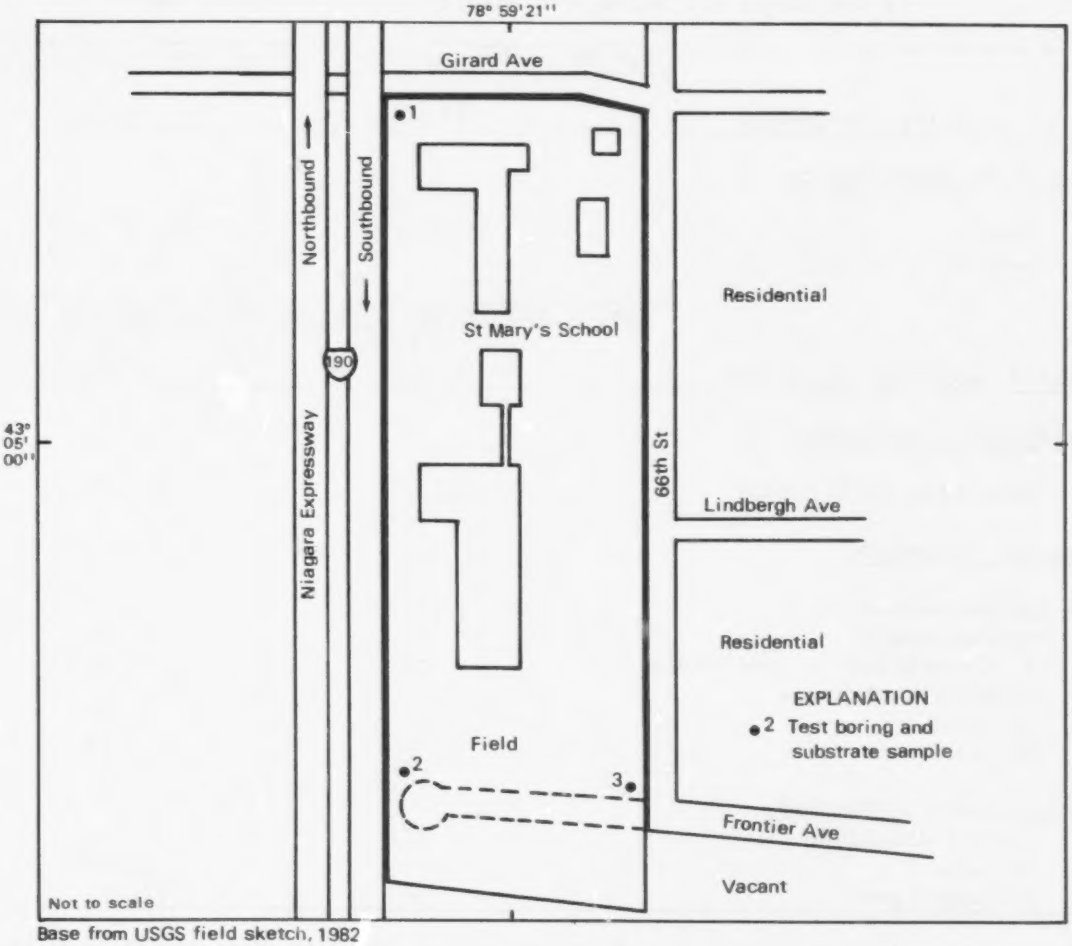


Figure C-56. Location of sampling holes at St. Mary's School, site 238, Niagara Falls.

Boring no.	Depth (ft)	Description
1	0 - 2.5	Topsoil.
	2.5 - 3.0	Sand, fine, yellow, damp.
	3.0 - 5.5	Clay, yellow.
	5.5 - 6.0	Sand, yellow, damp.
	6.0 - 6.5	Clay, red.
		SOIL SAMPLE: 2.5 ft.
2	0 - 1.5	Topsoil.
	1.5 - 2.5	Same.
	2.5 - 4.5	Sand, yellow, fine, dry.
	4.5 - 5.0	Clay, sandy, wet.
	5.0 - 6.0	Sand, yellow, fine, wet.
	6.0 - 6.5	Clay, red, dry.
		SOIL SAMPLE: 5 ft.
3	0 - 3	Topsoil and sand.
	3 - 4.5	Clay, yellow
	4.5 - 6.0	Sand, yellow, wet.
	6.0 - 6.5	SOIL SAMPLE: 5 ft.

Chemical information.--The U.S. Geological Survey collected three soil samples for iron, mercury, and organic-compound analyses; results are given in table C-35. The samples contained four organic priority pollutants, two organic nonpriority pollutants, and some unknown hydrocarbons.

Table C-35.--Analyses of substrate samples from St. Mary's School, site 238, Niagara Falls, N.Y.
(Locations shown in fig. C-56. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
First sampling (08-12-82)	1 (2.5)	2 (5.0)	(Split)	3 (5.0)
Inorganic constituents				
Iron	1,400,000	1,700,000	(130,000)	1,700,000
Mercury	--	--	(--)	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Compounds detected but not quantified--Holding time exceeded before GC/MS acid- and base-neutral extractable compounds were extracted.

Table C-35.--Analyses of substrate samples from St. Mary's School, site 238, Niagara Falls, N.Y. (continued)
(Locations shown in fig. C-56. Concentrations are in µg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft) (samples taken from first sand layer)		
Second sampling (05-29-83)	1A (2.5)	2A (2.5)	3A (2.5)
Organic compounds			
Priority pollutants			
Heptachlor	LT	LT	--
Heptachlor epoxide	--	LT	--
Bis(2-ethylhexyl) phthalate	*	*	--
Di-n-octyl phthlate	*	*	--
Nonpriority pollutants			
trans-1,2-Dichloro-cyclohexane[1]	--	*	--
cis-1,3-Dichloro-cyclohexane[1]	--	--	*
Unknown hydrocarbons[1]	*	--	--

242. CHARLES GIBSON SITE (Literature review)

NYSDEC 932063

General information and chemical-migration potential.--The Charles Gibson site, in the eastern part of the town of Niagara, on Cayuga Creek, was used as a disposal site during 1955-57 for 403 drums (about 90 tons) of hexachlorobenzene and 101 truckloads (about 1,000 tons) hexachlorocyclohexane (BHC) cake.

A remedial investigation program has been developed by the site owner in response to the NYSDEC Division of Environmental Enforcement to assess the extent of past disposal practices and impact on the ground water and surface water in the area. The potential for contaminant migration is major because of the proximity to the creek and the nature of the buried material.

Geologic information.--No data are available at present. The site probably consists of a lacustrine clay deposit overlying bedrock of Lockport Dolomite.

Hydrologic information.--No data are available at present. Ground water would probably occur at or near stream stage. The direction of ground-water flow is probably eastward toward the stream.

Chemical information.--Sampling by the NYSDEC in 1982 indicated that the waste material contains BHC's in concentrations exceeding 90,000,000 µg/kg.

244. 93RD STREET SCHOOL (Literature review) NYSDEC 932078

General information and chemical-migration potential.--The 93rd Street School is in the city of Niagara Falls. The school property was used to dispose of 3,000 yd^3 of fly ash and hexachlorocyclohexane (BHC) cake that had been removed from Love Canal in 1954. Soil samples taken on the property were found to be contaminated with trichlorobenzene and tetrachlorobenzene. The U.S. Environmental Protection Agency included the investigation of this site in their 1982 Love Canal Monitoring Report.

The potential for contaminant migration is indeterminable. Results of the U.S. Environmental Protection Agency investigation has been used to assess the effect of the buried material on the ground water.

Geologic information.--This site and adjacent areas consist of fill and glacial unconsolidated deposits of lacustrine clays and till underlain by Lockport Dolomite and Rochester Shale. A general stratigraphic column for a site in the vicinity is given on page 314 (Love Canal, site 38).

Hydrologic information.--Ground-water flow through unconsolidated deposits is probably northward toward Bergholtz and Black Creeks, westward to Cayuga Creek, and southward to Little Niagara and Niagara Rivers. Ground-water gradients in the Lockport Dolomite indicate that the direction of flow is south and southwest toward the Niagara River.

Velocities for horizontal flow are 0.001 in/yr in the clay and 1 to 60 ft/yr in the other overburden. Permeability ranges from 10^{-8} cm/s to $\geq 10^{-5}$ cm/s. Transmissivity of the Lockport Dolomite has been calculated to be 0.015 ft^2/s, and the storage coefficient to be 1.49×10^{-4} (U.S. Environmental Protection Agency, 1982). Additional information on ground-water flow is given in the description of Love Canal, site 38 (p. 313).

Chemical information.--Chemical data from USEPA include ground water, surface water, sediment, waste, and surface soil. Ground water in unconsolidated deposits and in bedrock was found to contain traces of benzene and toluene (less than 25 µg/L). Storm sewers on 93rd Street adjacent to the school contained Lindane in concentrations ranging from 15 to 97 µg/L. Soil samples from the upper 6 inches of the school grounds contained cadmium ranging from 1,200 to 1,700 µg/kg. Traces of benzene (not exceeding 25 µg/kg) were also found in soil at the school. Low-level Lindane contamination was detected in the fly-ash fill; the fly ash was also found to contain 0.380 µg/kg of dioxin. Lindane contamination was also found on the school ball diamond. Sediment in a storm sewer discharging from the school area into Bergholtz Creek was found to contain 29 µg/kg of dioxin.

Source of data.--U.S. Environmental Protection Agency, 1982, Environmental monitoring at Love Canal: U.S. Environmental Protection Agency, 2 vols.

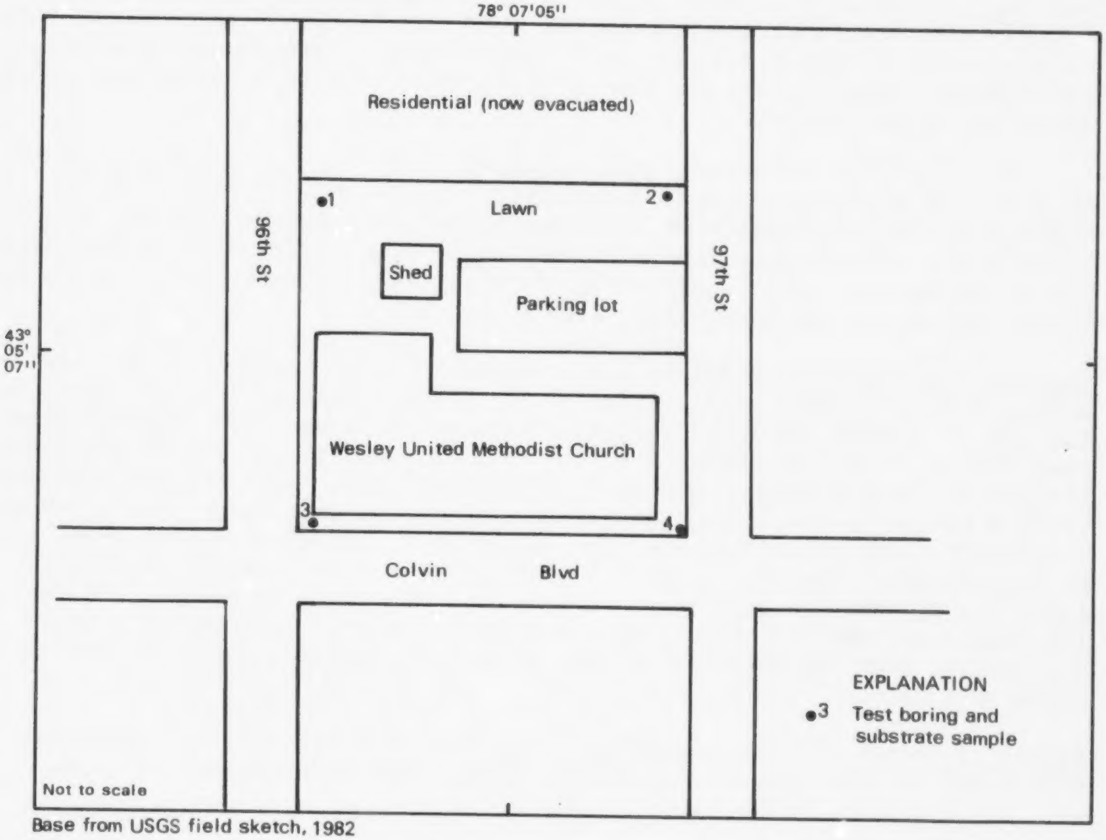
245. 97TH STREET METHODIST CHURCH (USGS field reconnaissance) NYSDEC 932084

General information and chemical-migration potential.--The 97th Street Methodist Church property, in the city of Niagara Falls, was used for disposal of 23 tons of broken concrete cells from Olin Corporation in 1958.

The potential for contaminant migration is indeterminable. The extensive clay unit underlying the site may inhibit downward migration; although the chemical analyses indicate high concentrations of some organic priority pollutants, they do not indicate offsite migration.

Geologic information.--The site consists of a lacustrine clay about 26 ft thick overlying bedrock of Lockport Dolomite. The U.S. Geological Survey drilled four test borings on the site in 1982; the locations are shown in figure C-57. The geologic logs are on page 418.

Hydrologic information.--During the test drilling, the clay became moist at 11.5 ft below land surface and remained so to the top of bedrock. The general direction of ground-water flow in the unconsolidated deposit is probably southward.



Base from USGS field sketch, 1982

Figure C-57. Location of monitoring wells and sampling holes at 97th St. Methodist Church, site 245, Niagara Falls.

Chemical information.--The U.S. Geological Survey collected four soil samples and one water sample for iron, mercury, and organic-compound analyses; results are shown in table C-36. No mercury was detected. The ground-water sample contained three organic priority pollutants, two of which were in concentrations above 250,000 μg/L.

Table C-36.--Analyses of substrate and ground-water samples from 97th Street Methodist Church, site 245, Niagara Falls, N.Y., August 27, 1982. [Locations shown in fig. C-57. Concentrations are in μg/kg and μg/L; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)				
	Substrates				Ground water
	1 (16.5)	2 (11.5)	3 (8.0)	4 (26.0)	4A (20.0)
pH					7.0
Specific conductance (μmho/cm)					2,730
Inorganic constituents					
Iron	6,500,000	5,200,000	4,300,000	2,400,000	
Mercury	--	--	--	--	
Organic compounds					
Priority pollutants					
Diethyl phthalate	--	--	--	--	LT
Butylbenzyl phthalate	--	--	--	--	315,000
Bis(2-ethylhexyl) phthalate	--	--	--	--	252,000†
Possible artifact					
4-Methyl-3-penten-2-one[1]	--	880	--	--	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

† Exceeds USEPA criterion for maximum permissible concentration in drinking water or New York State standard for maximum concentration in ground water.

Boring no.	Depth (ft)	Description
1	0 - 1.5	Brown topsoil
	1.5 - 6.5	Clay, pink.
	6.5 -11.5	Clay, pink.
	11.5 -16.5	Clay, pink.
		SOIL SAMPLE: 16.5 ft.
2	0 - 1.5	Topsoil.
	1.5 - 6.5	Clay, pink.
	6.5 -11.5	Clay, pink.
		SOIL SAMPLE: 11.5 ft.
3	0 - 1.5	Topsoil.
	1.5 - 6.5	Clay, pink.
	6.5 - 8.0	Clay, pink.
		SOIL SAMPLE: 8 ft.
4	0 - 1.5	Topsoil.
	1.5 - 6.5	Clay, pink.
	6.5 -11.5	Clay, pink.
	11.5 -16.5	Clay, pink, some gravel.
	16.5 -21.5	Clay, pink.
	21.5 -26	Clay, pink.
	26	Bedrock.
		WATER SAMPLE: 26 ft.

247. OLIN DEEP WELL (Literature review) NYSDEC 932037

General information and chemical-migration potential.--The Olin well, at the Olin Plant site on Buffalo Avenue in Niagara Falls, is 125 ft deep and was used to dispose of approximately 130,000 tons of end liquor (60 to 65 percent water, 30 percent sulfuric acid, 5 to 10 percent sodium chlorate). The well was deactivated in 1977. No geologic, hydrologic or chemical information is available. The potential for contamination migration is indeterminable.

251. SOLVENT CHEMICAL (Literature review) NYSDEC 932096

General information and chemical-migration potential.--The Solvent Chemical site, in the city of Niagara Falls (fig. C-58), was used for the production of chlorinated benzenes (dichloro-, trichloro-, and tetrachlorobenzene) during 1974-78. Earlier occupancy of the site is reported to have been by area chemical firms.

This site has a major potential for contaminant migration. Contaminants are moving offsite via sewerline infiltration and may also be migrating in the overburden and penetrating into the bedrock.

Geologic information.--The site consists of fill, recent alluvium including silt, silty clay, fine to medium sand, and discontinuous till and clay with a total depth varying from 5 to 10 ft. This material overlies the Lockport Dolomite bedrock.

The site owner dug several test pits in 1980; descriptions are on page 420.

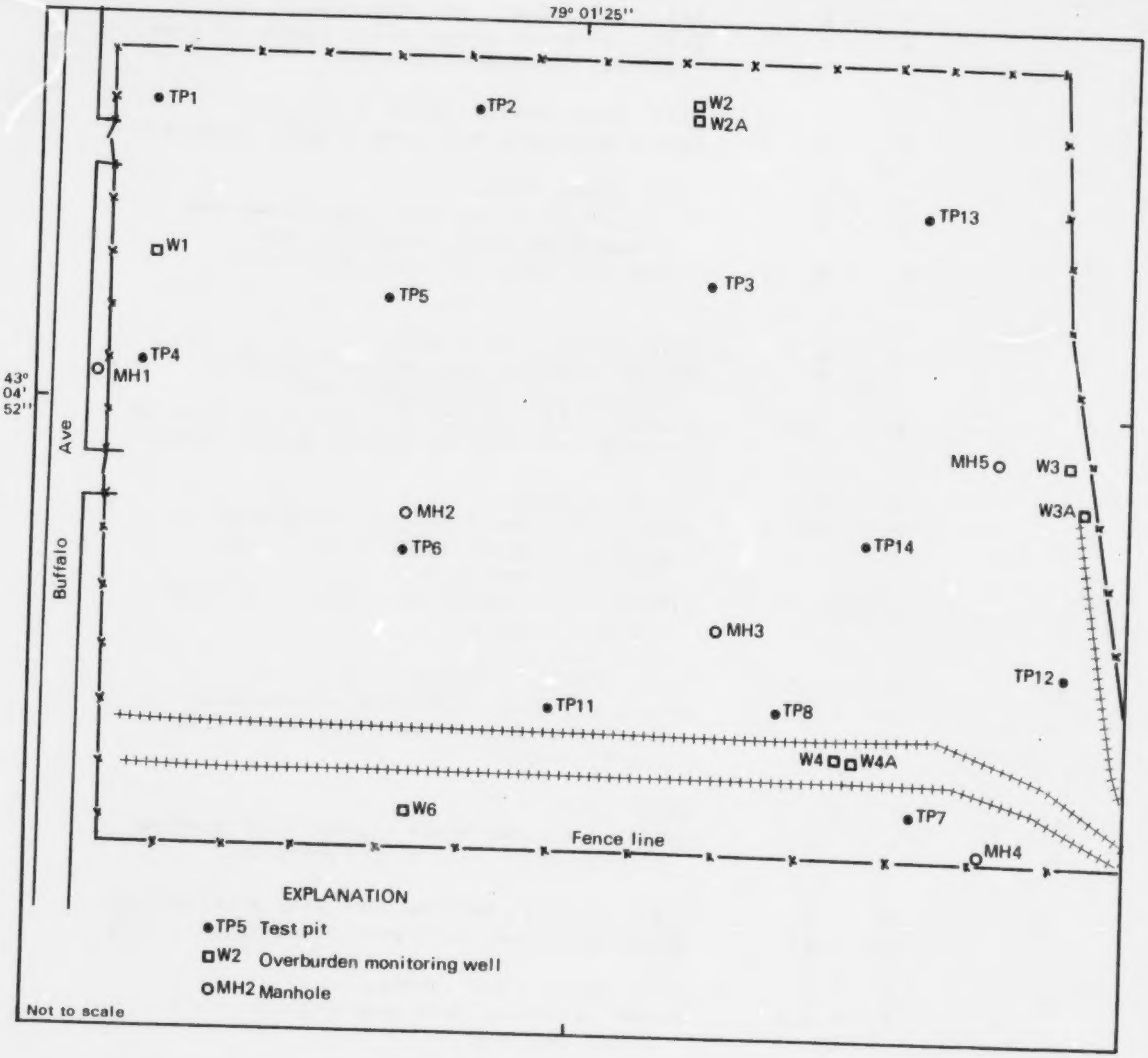


Figure C-58. Location of monitoring wells at Solvent Chemical, site 251, Niagara Falls.

Test pit no.	Depth (ft)	Description
1	0 - 1.5	Fill, black cinders and loose rubble.
	1.5 - 6.5	Recent alluvium; mottled light brown and orange brown silt; some fine sand.
	6.5 - 8	Lacustrine clay; red brown laminated and silty; gray-filled joints.
2	0 - 5	Fill; black cinders; loose debris mixed with silty brown soil.
	5 - 6	Recent alluvium; dark gray organic silt.
	6 - 9	Till; red-brown clayey silt; coarse to fine gravel; occasional cobbles.
3	0 - 8	Fill; loose debris, brick fragments.
	8 - 9	Recent alluvium; dark gray organic sandy silt.
4	0 - 1	Black cinder fill.
	1 - 8	Recent alluvium; mottled light-brown and orange-brown silt; some fine sand.
	8 - 9	Lacustrine clay; red-brown silty clay.
5	0 - 4.5	Black cinders and debris.
	4.5 - 6	Recent alluvium; mottled gray and brown clayey silt; little fine sand.
	6 - 8.5	Glacial till; red brown clayey silt; fine to coarse sand; little fine to medium gravel.
6	0 - 5.5	Black cinderfill.
	5.5 - 6.5	Recent alluvium; dark gray organic silt; grading to gray clayey silt; little medium to fine sand.
	6.5 - 7.5	Glacial till; red-brown clayey till; sand and some gravel.
7	0 - 4.2	Fill; rubble, cinders, wood
	4.2 - 8.0	Recent alluvium; dark gray organic silt grading to gray brown clayey silt with little sand.
8	0 - 4	Rubble fill.
	4 - 6.5	Recent alluvium; black organic silt grading to gray brown silt with fine sand.
11	0 - 5	Fill; cinders, debris, dark gray silty soils.
	5 - 6	Recent alluvium; dark-gray brown organic silt.
12	0 - 5	Fill; cinders and rubble.
	5 - 6.5	Recent alluvium; dark gray organic clayey silt; fine sand.
13	0 - 4.5	Fill; debris and dark brown soils.
	4.5 - 5.6	Recent alluvium; dark gray organic silt grading to mottled orange brown fine sandy silt.
14	0 - 5	Fill; dark brown silty soil and debris.
	5 - 8	Recent alluvium; dark brown organic silt grading to dark gray sandy silt.

Table C-37.--Analyses of ground-water samples from Solvent Chemical, site 151, Niagara Falls, N.Y., July-August 1980.
[Well locations shown in fig. C-59. Concentrations are in µg/L.]

Constituent or characteristic	Well number								
	W-1	W-2	W-2A	W-3	W-3A	W-4	W-4A	W-5	W-6
pH	12.4	7.35	7.06	7.51	7.54	6.80	6.88	7.86	6.64
Specific conductance µmho/cm	8,400	1,500	5,000	2,490	2,230	5,500	2,740	7,400	8,000
Total organic carbon	51,000	36,000	29,000	53,000	28,000	38,000	35,000	850,000	38,000
Ammonia, as nitrogen	3,600	8.900	2,000	2,000	5,000	15,000	4,000	13,000	240,000
Chloride	64,000	210,000	1,200,000	230,000	380,000	1,800,000	480,000	1,900,000	2,600,000
Zinc, total	6.3	42	0.040	6.7	0.047	22	4.5	20	230
ortho-Dichlorobenzene	87	79	1,500	2,700	2,900	260,000	16,000	31,000	1,400
meta-Dichlorobenzene	18	11	290	2,000	860	27,000	2,700	9,600	420
para-Dichlorobenzene	65	40	410	5,800	2,700	87,000	7,400	74,000	650
1,2,3,-Trichlorobenzene	5	<2	150	52	180	10,000	410	1,500	69
1,2,4,-Trichlorobenzene	19	14	900	150	570	67,000	1,700	8,000	690
1,3,5-Trichlorobenzene	<5	<10	<80	<10	<90	<10	<80	<800	<40
Monochlorobenzene	4,000	3,900	12,000	110,000	22,000	4,100	54,000	110,000	1,200
Benzene	4,800	4,500	3,300	58,000	5,700	1,600	41,000	170,00	3,600

Hydrologic information.--The site surface is quite level, ranging from 567 ft to 569 ft above sea level. Ground-water altitude during July through September 1980 ranged from 553 ft to 569 ft. The direction of ground-water movement may be northward toward Buffalo Avenue.

Chemical information.--The owner installed nine monitoring wells in the unconsolidated deposits at the site in July and August 1980. Samples from these wells indicate the highly elevated levels of ammonia, zinc, and organic compounds (table C-37). The analysis of water from the wells tapping overburden indicate considerable variation within the site.

255. STAUFFER CHEMICAL PLANT - POWER AUTHORITY OF THE STATE OF NEW YORK (USGS field reconnaissance) NYSDEC 932053

General information and chemical-migration potential.--The Stauffer Chemical Plant (PASNY) site, on the north side of the PASNY forebay in the town of Lewiston, was used to dispose unknown quantities of asbestos, graphite, cinders, concrete cell parts, reactor linings, scrap sulfur and metal, silicon, zirconium, and titanium oxides.

The potential for contaminant migration is indeterminable. Contaminants may migrate during the periods of excessive precipitation, but additional monitoring would be required to document the migration. Bechtel, Inc. is conducting an investigation of the former plant site and disposal sites.

Geologic information.--The site consists of fill overlying a thin unit of clay that overlies bedrock of Lockport Dolomite. The U.S. Geological Survey drilled four test holes on the site in 1982; locations are shown in fig. C-59. The geologic logs are as follows:

Boring no.	Depth (ft)	Description
1	0 - 3	Fill, topsoil, dark brown.
	3 - 4.5	Fill, light gray.
	4.5 - 8.0	Clay, red, damp.
	8.0	Bedrock.
		SAMPLE: 5 ft.
2	0 - 4.0	Topsoil.
	4.0 - 6.5	Clay, yellow, brown, dry.
		SAMPLE: 4 ft.
3	0 - 3.0	Topsoil.
	3.0 - 7.5	Clay, brown-red.
	7.5	Bedrock.
		SAMPLE: 4 ft.
4	0 - 2	Black fill material.
	2 - 6.5	Clay.
		SAMPLE: 2 ft.

Hydrologic information.--No ground water was encountered during the test drilling.

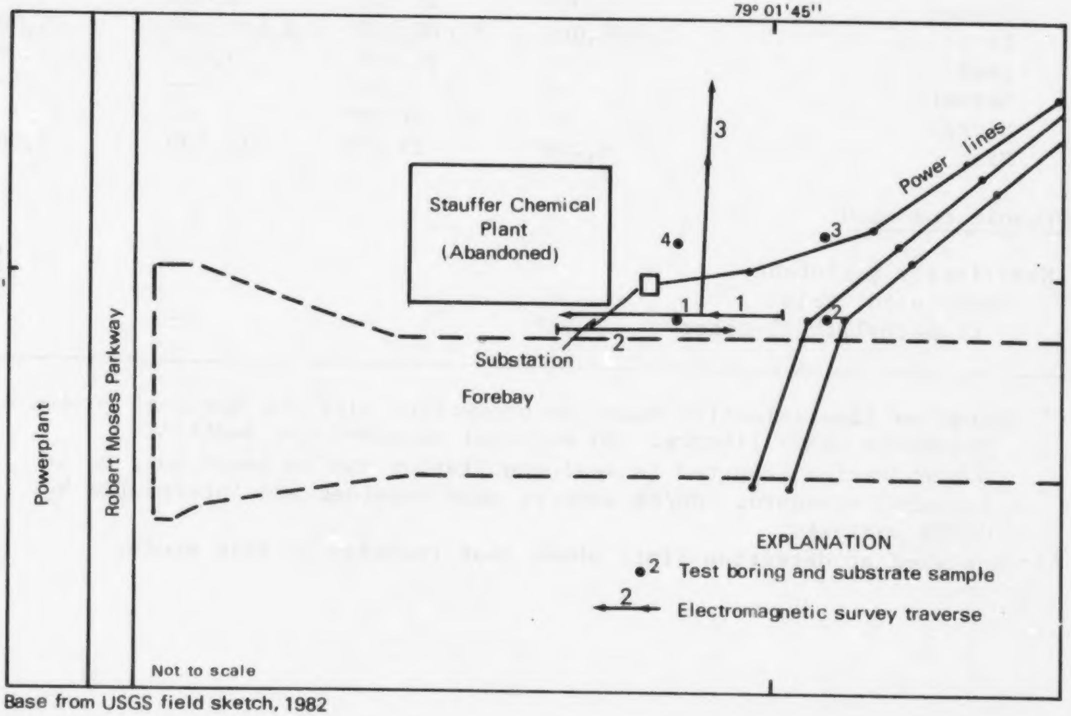
Chemical information.--The U.S. Geological Survey collected four soil samples for arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, zinc, and organic-compound analyses; results are shown in table C-38. None of the heavy metals exceeded concentrations found in undisturbed soils not affected by waste-disposal practices. One organic nonpriority pollutant was found.

Electromagnetic survey.--The U.S. Geological Survey conducted an electromagnetic survey with three traverses over the site. The locations are shown in fig. C-59; the data are plotted in figure C-60.

Both lines 1 and 2 parallel the forebay area near a former chemical plant, and both indicate high bedrock at this site.

Line 1, along a road approximately 50 ft from the forebay cliff, shows a gradual westward decline in conductivity that is probably due to the rise in bedrock in this direction.

Line 2, parallel to line 1 but within 20 ft of the forebay cliff, shows the effects of bedrock (here within 2 ft of the surface) even more clearly. Neither line gives any indication of artificially elevated conductivity.



Base from USGS field sketch, 1982

Figure C-59. Location of sampling holes and electromagnetic-conductivity survey at Stauffer Chemical Plant, PASNY, site 255, Lewiston.

Line 3.--This line gives strong indications of artificial fill in an area of high reeds 350 to 450 ft north of the dirt road. Evidence of a buried (metallic) conductor is also indicated 200 ft north of line 1. Background values at the north end of line 3 are lower than those at the southern end and probably reflect a change in surficial geology.

Table C-38.--Analyses of substrate samples from Stauffer Chemical, site 255, Niagara Falls, N.Y., August 12, 1982.
[Locations shown in fig. C-59. Concentrations are in μg/kg; dashes indicate that constituent or compound was not found, LT indicates it was found but below the quantifiable detection limit.]

	Sample number and depth below land surface (ft)			
	1 (5.0)	2 (4.0)	3 (4.0)	4 (2.0)
Inorganic constituents				
Arsenic	--	--	--	--
Cadmium	--	--	--	--
Chromium	2,000	6,000	3,000	1,000
Copper	5,000	11,000	6,000	--
Iron	2 900,000	5,600,000	2,600,000	75,000
Lead	--	10,000	10,000	--
Mercury	--	--	--	--
Nickel	--	10,000	--	--
Zinc	8,000	21,000	11,000	1,000
Organic compound	***			
Nonpriority pollutant				
Boric acid, Tris (1-methylethyl)-ester[1]	2,200	--	--	--

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[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library. No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

*** Analyzed at detection limit above that required by this study.

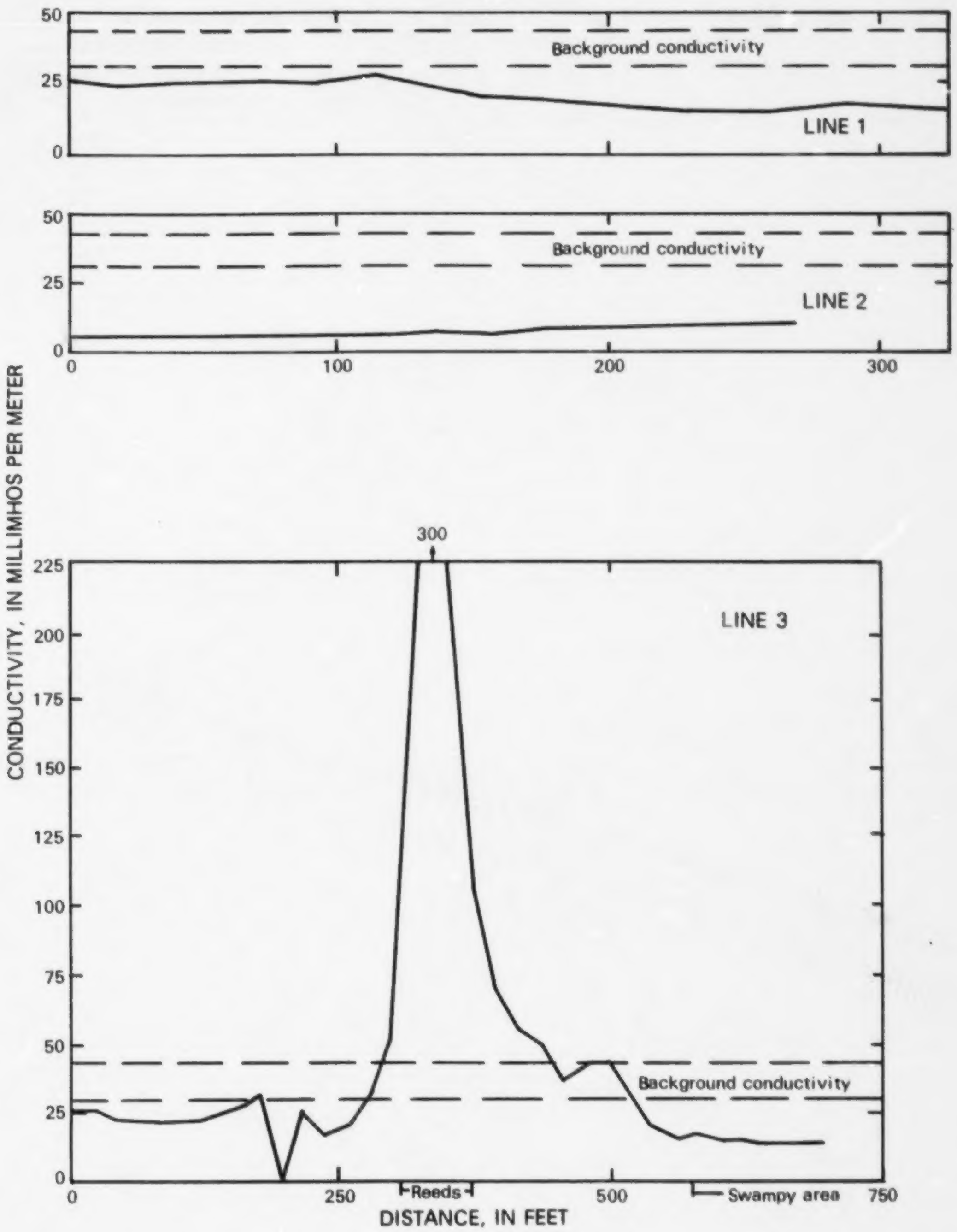

Figure C-60. Results of electromagntic-conductivity survey at Stauffer Chemical Plant, PASNY, site 255, Lewsiton, lines 1 through 3.

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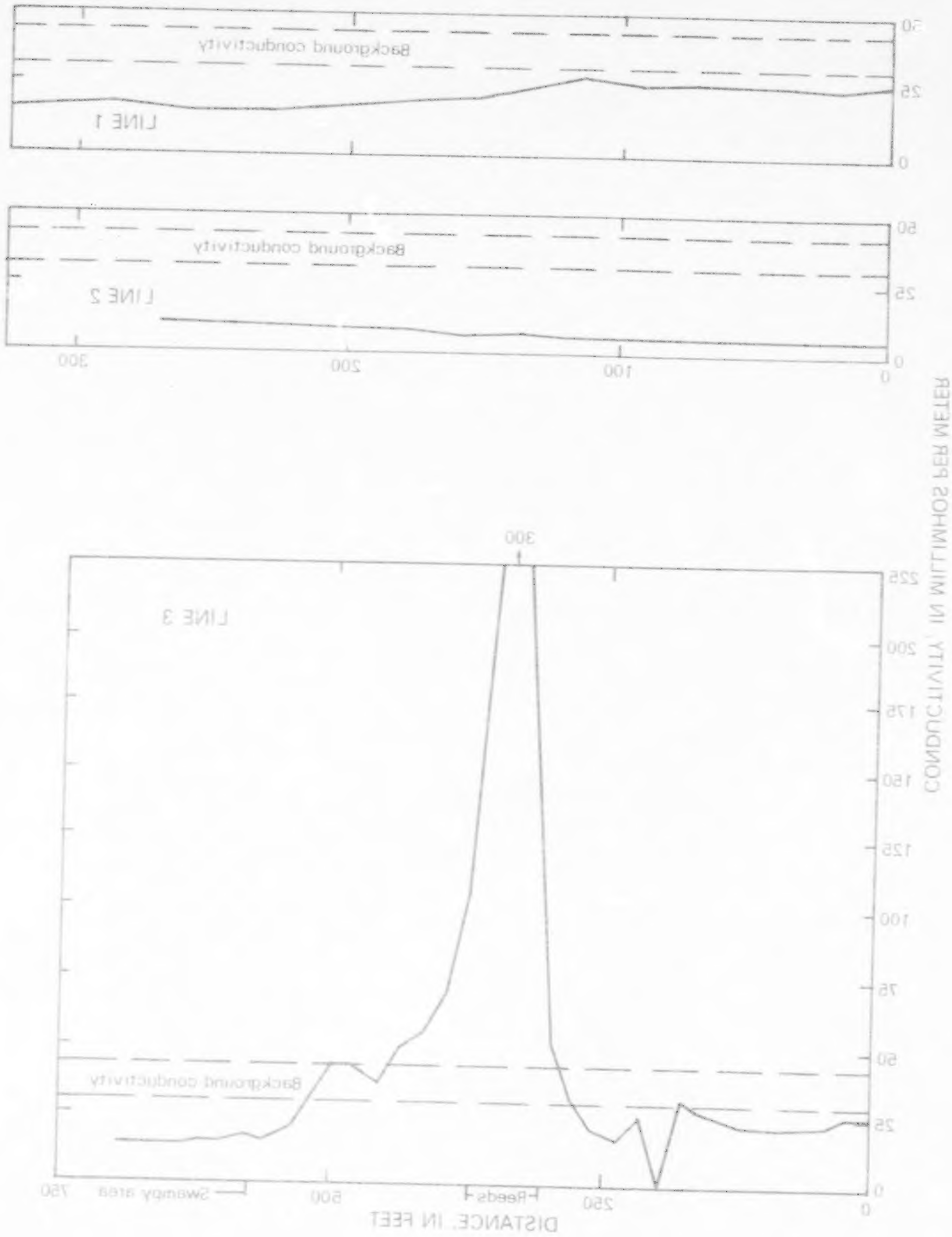

Figure C-60. Results of electromagnetic-conductivity survey at Stauffer Chemical Plant, PASNY, site 255, Lewiston, lines 1 through 3.

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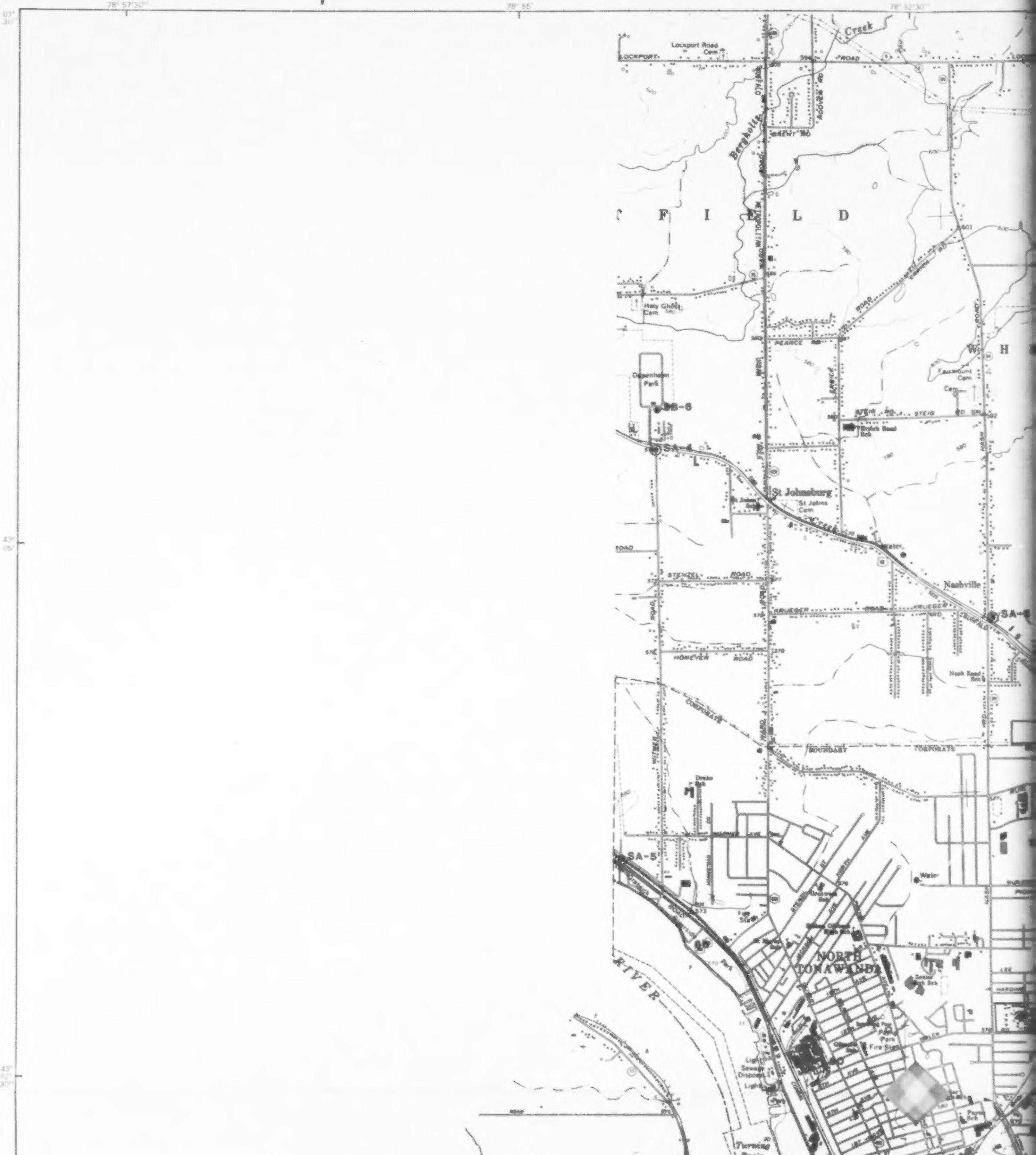

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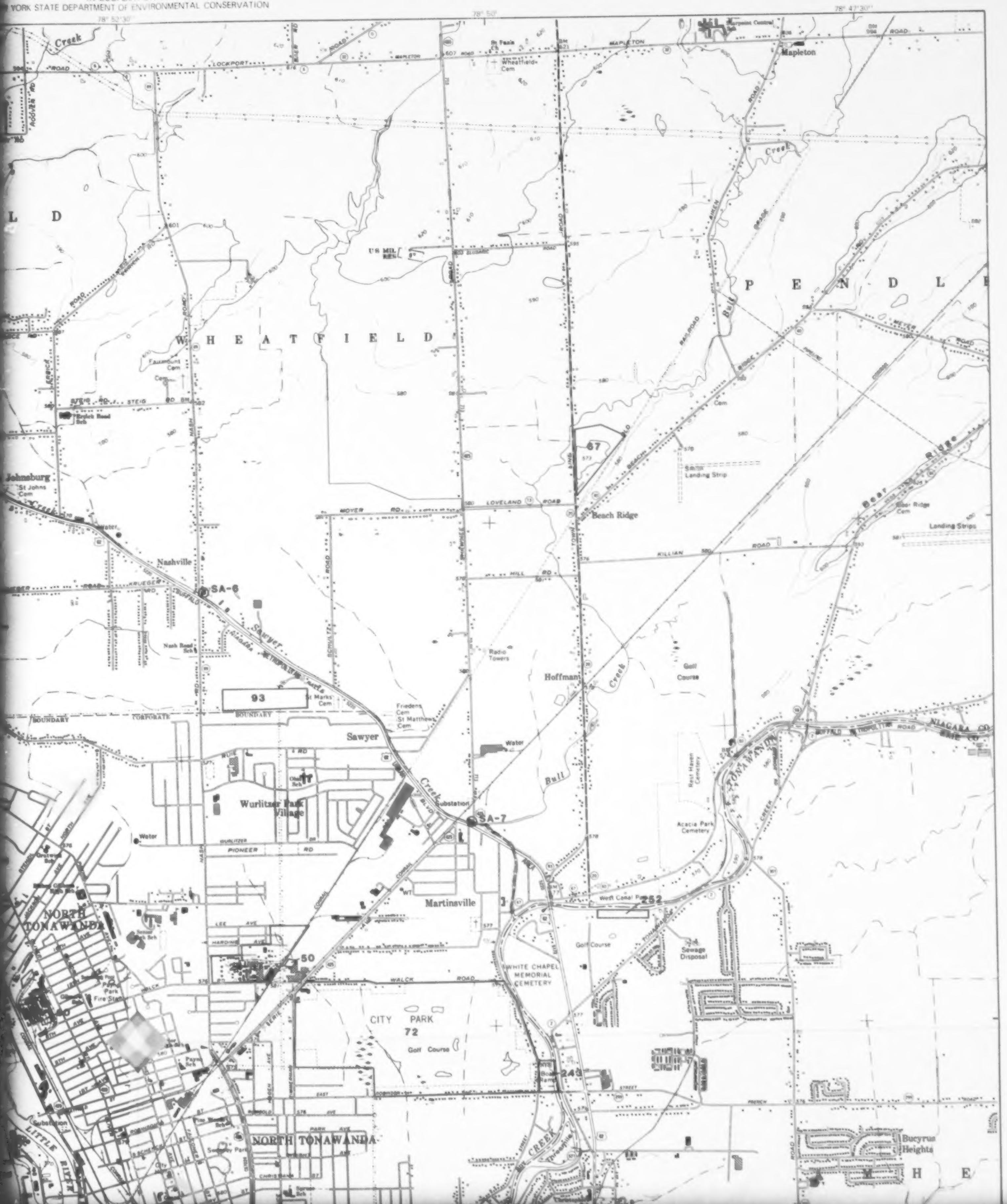
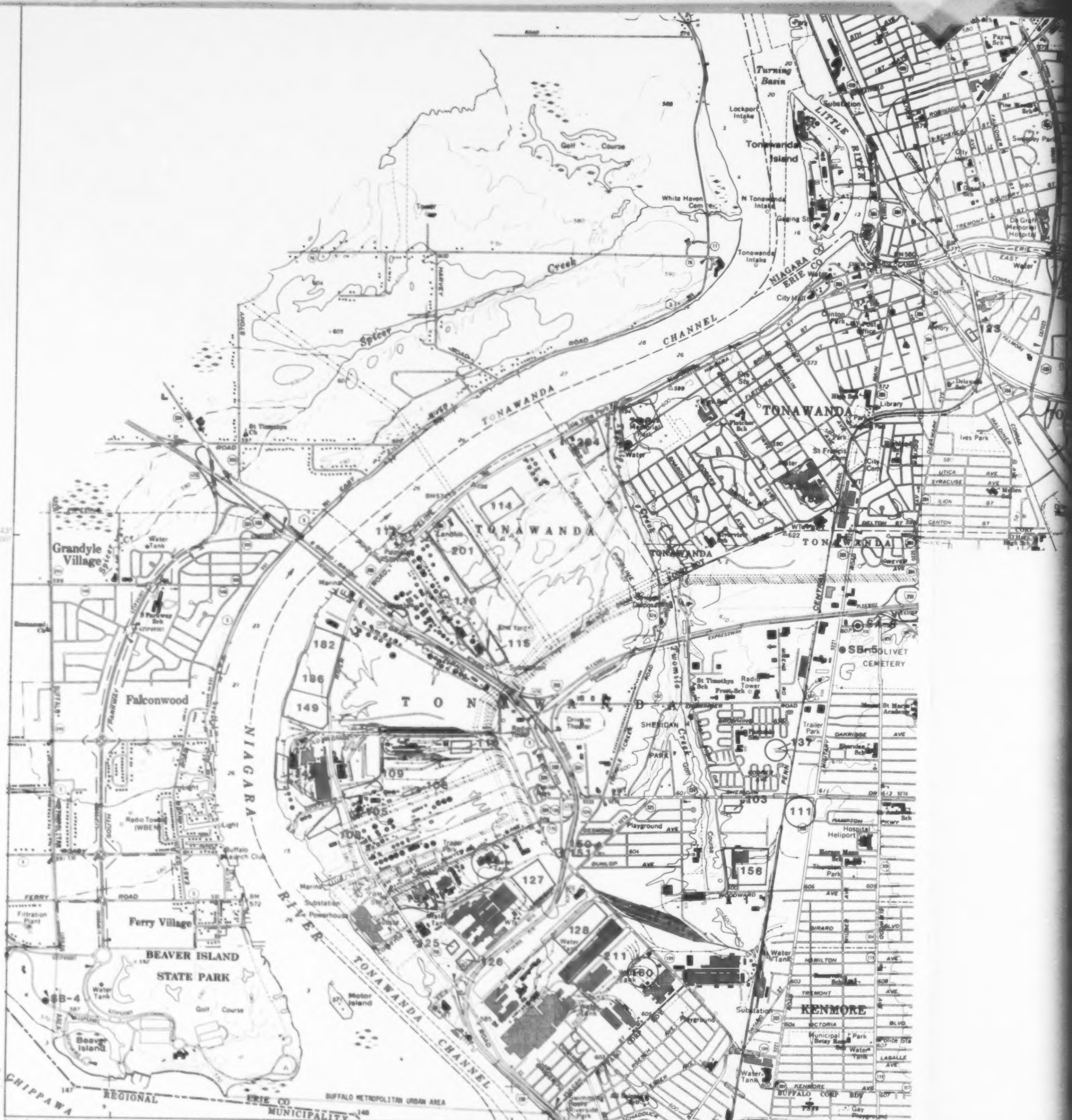
PLATE 2





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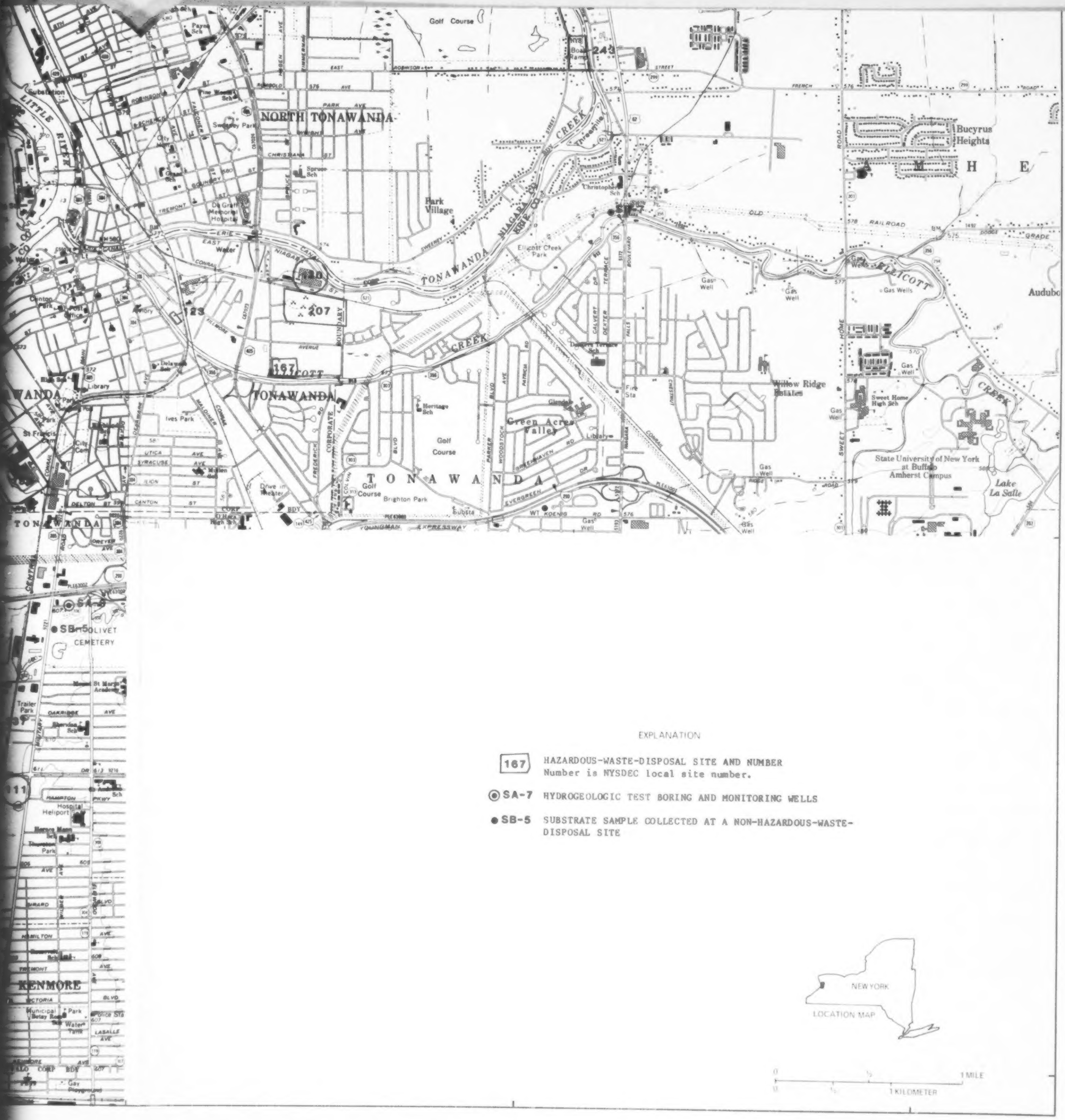

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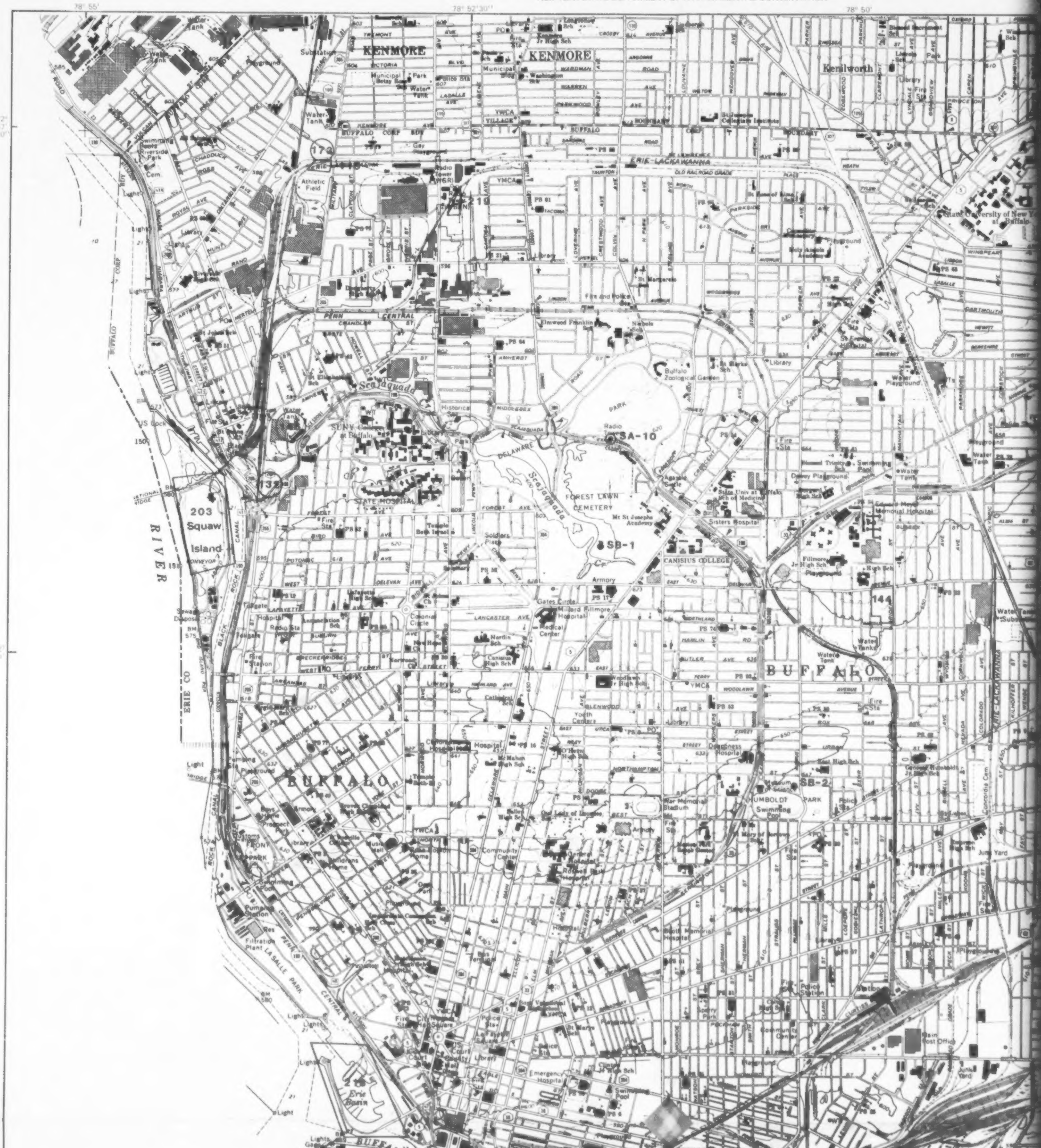

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PLATE 1

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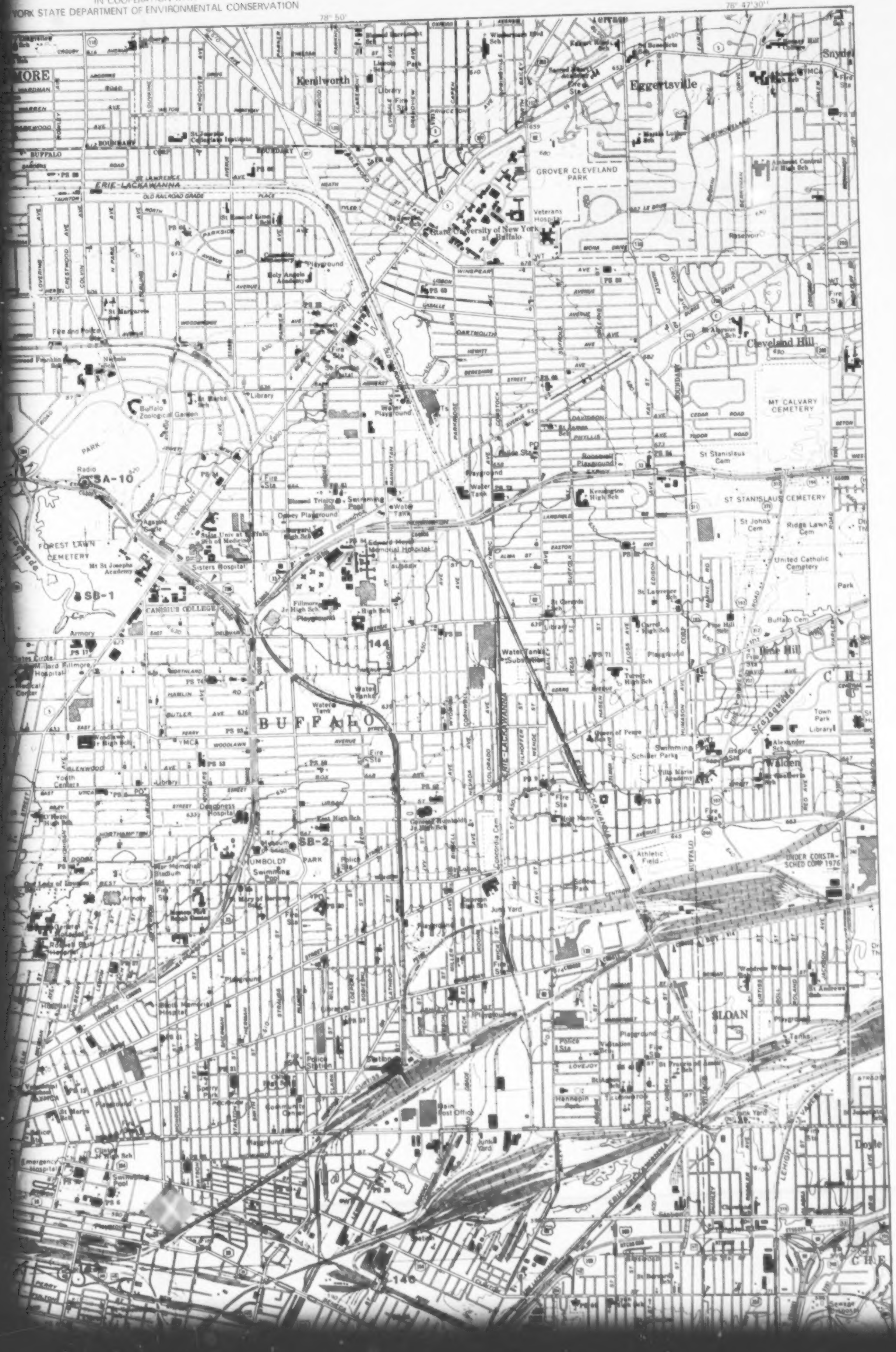

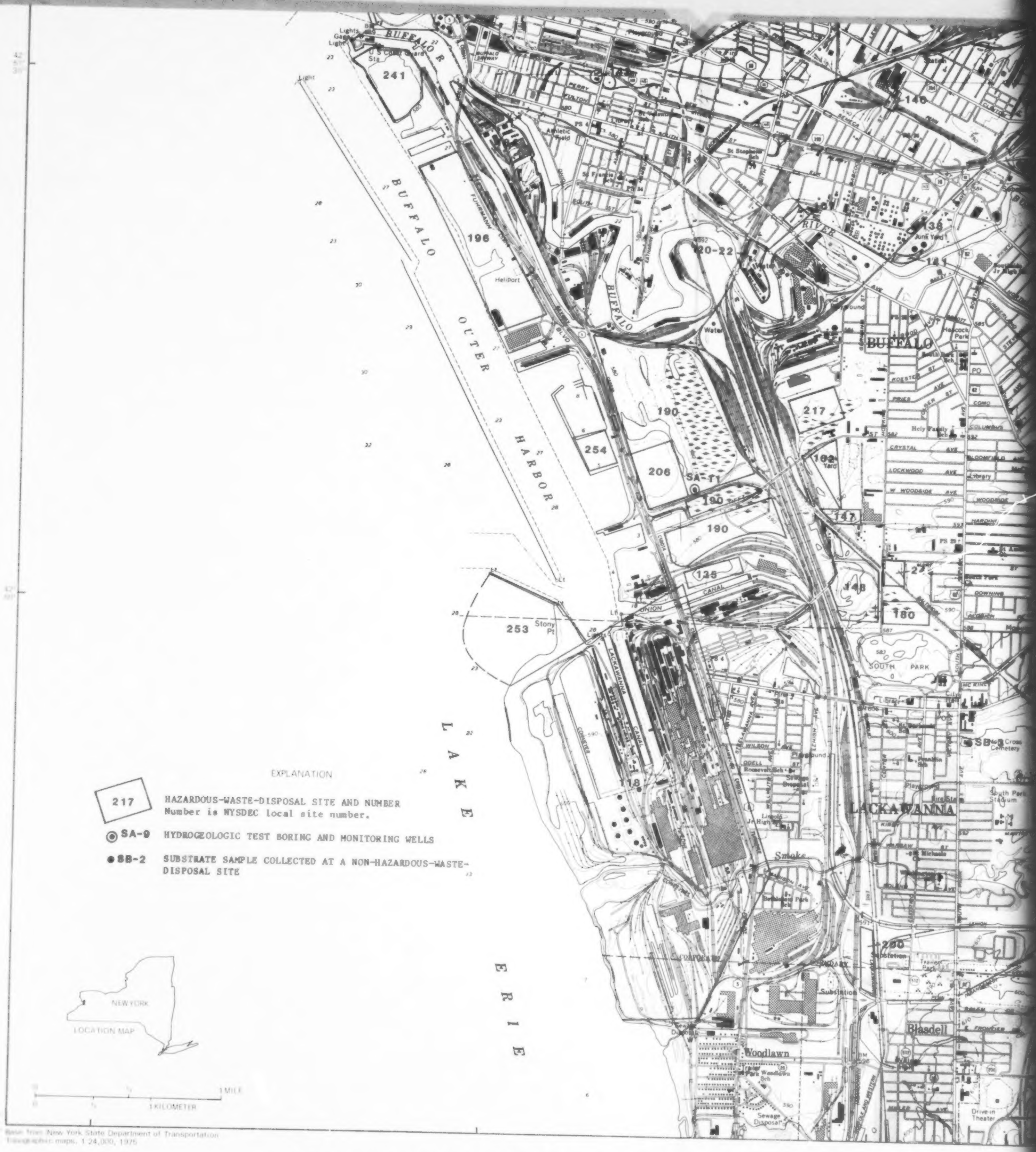

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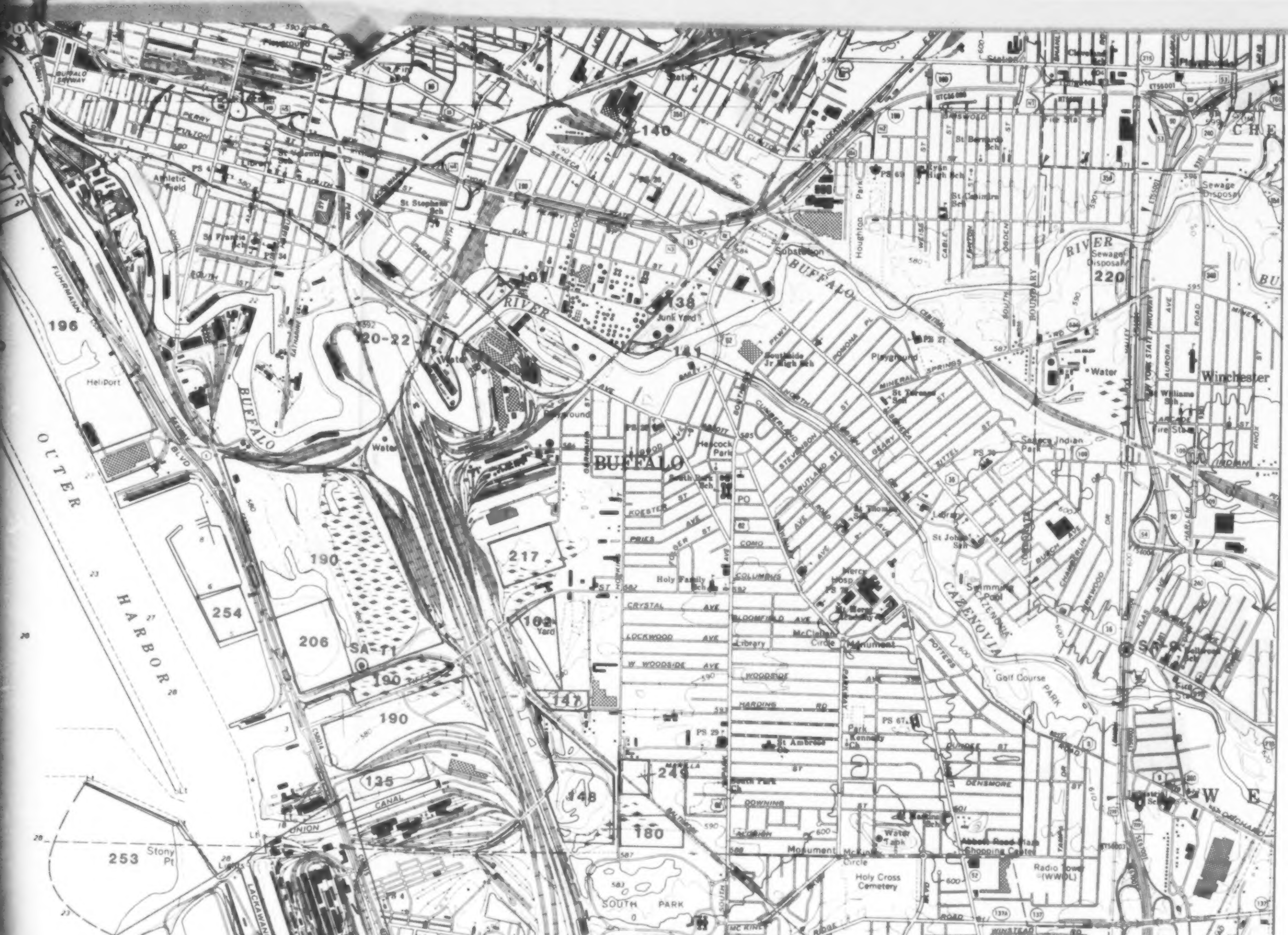

HAZARDOUS-WASTE-DISPOSAL SITES IN THE BUFFALO AREA, NY

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OF THE NIAGARA RIVER IN ERIE AND NIAGARA COUNTIES, NEW YORK

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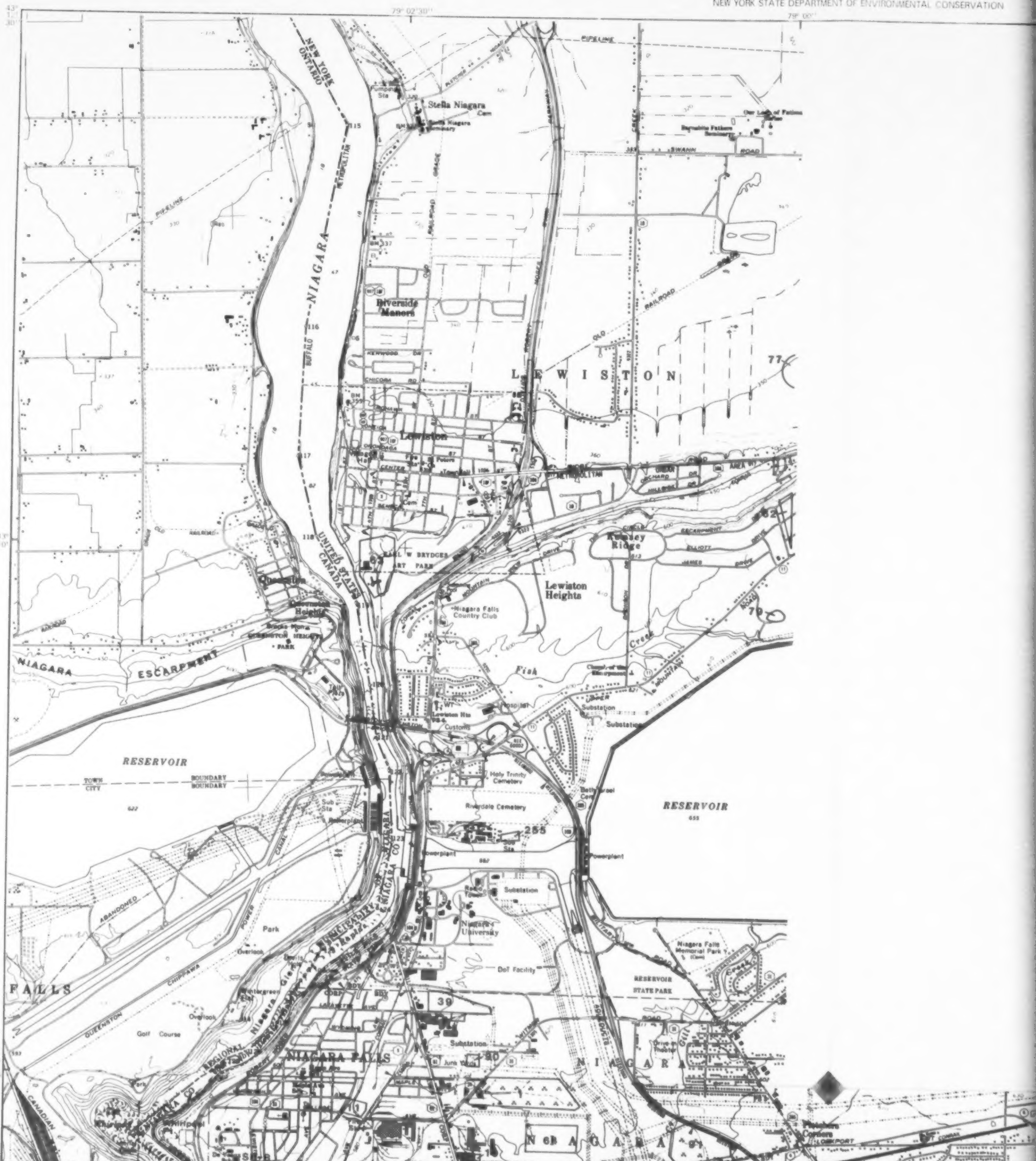

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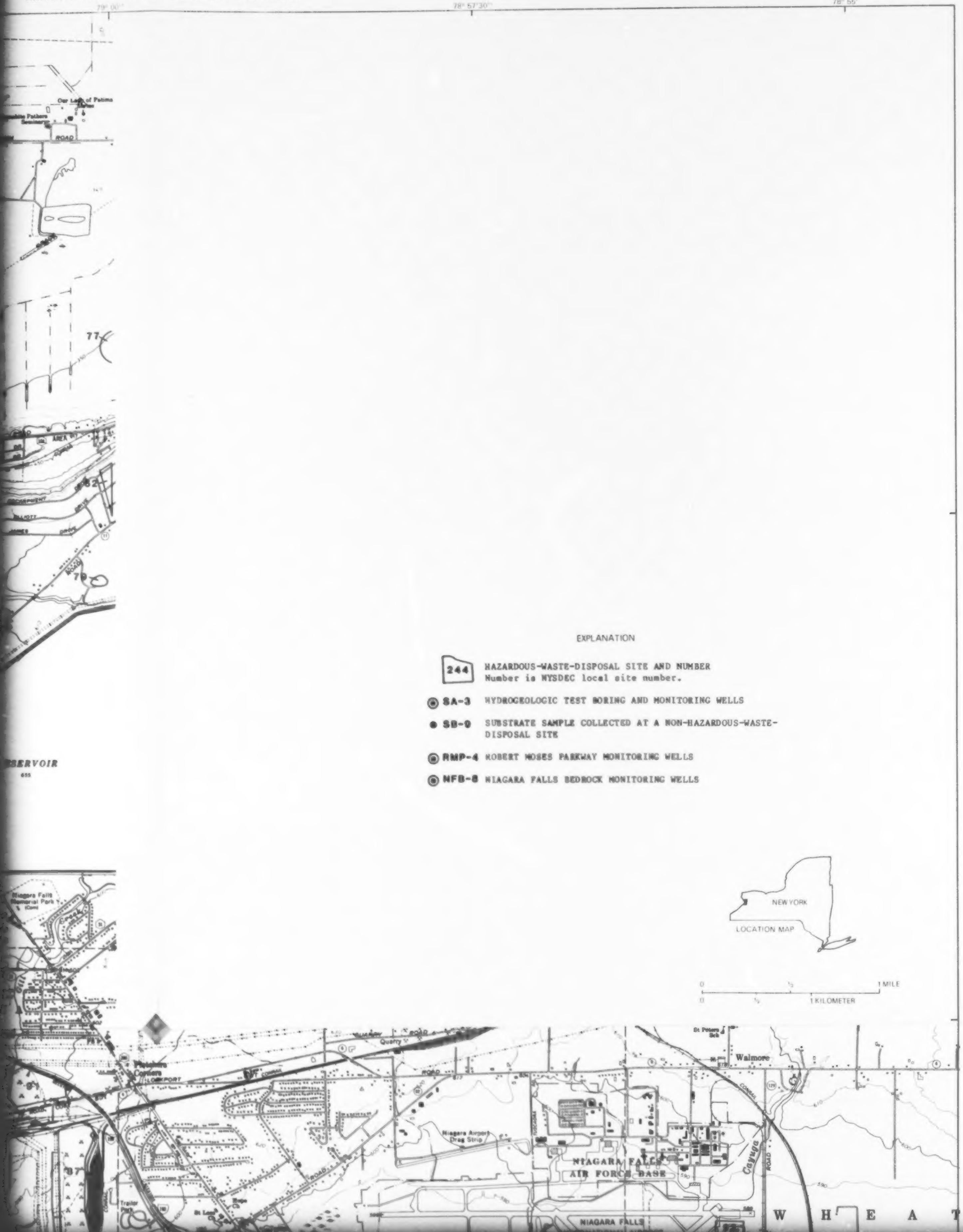
PLATE 3



EXPLANATION

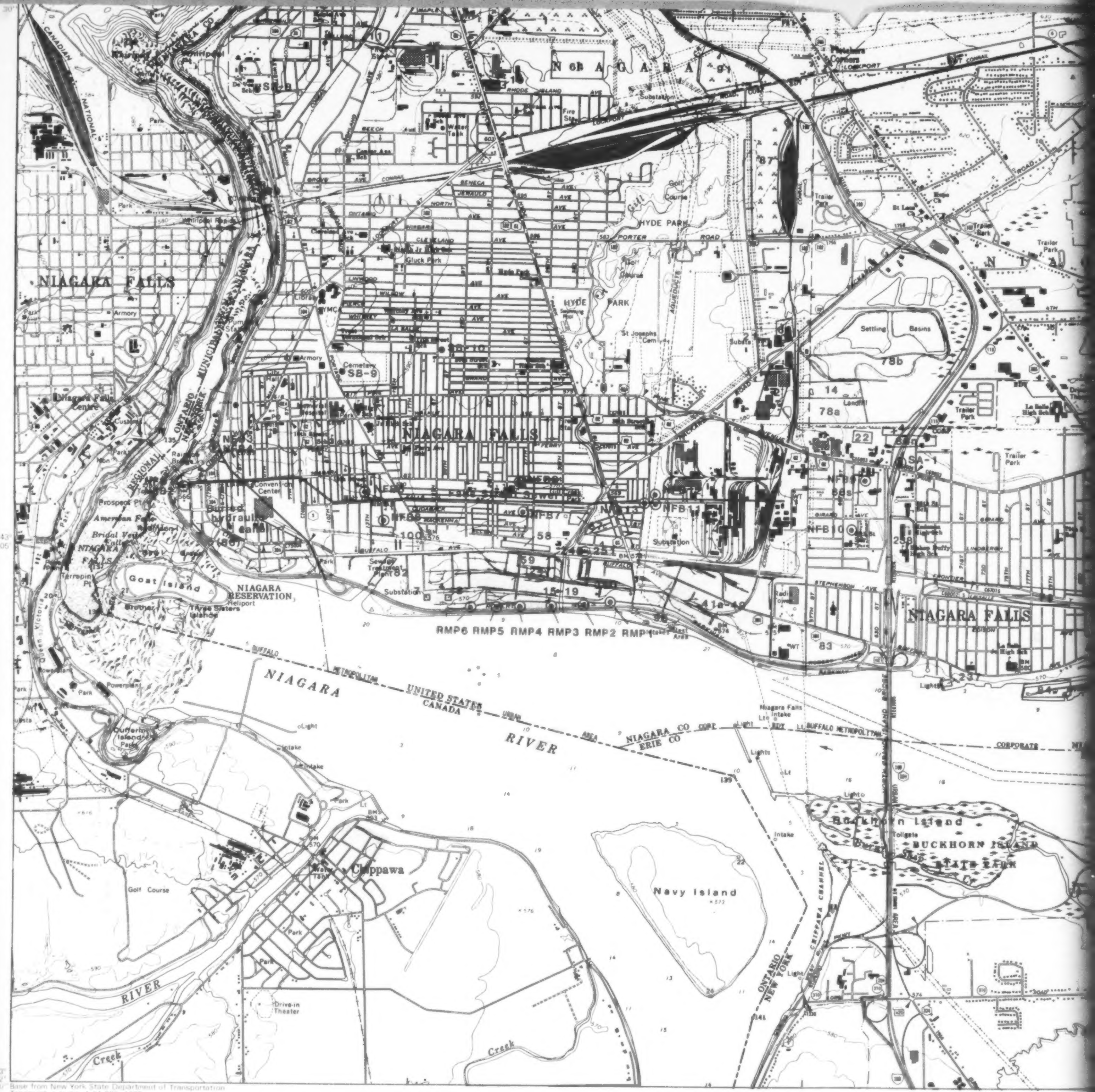
244 HAZARDOUS-WASTE-DISPOSAL SITE AND NUMBER
Number is NYSDEC local site number.

◉ SA-3 HYDROGEOLOGIC TEST BORING AND MONITORING WELLS

● SB-9 SUBSTRATE SAMPLE COLLECTED AT A NON-HAZARDOUS-WASTE-DISPOSAL SITE

◉ RMP-4 ROBERT MOSES PARKWAY MONITORING WELLS

◉ NFB-8 NIAGARA FALLS BEDROCK MONITORING WELLS



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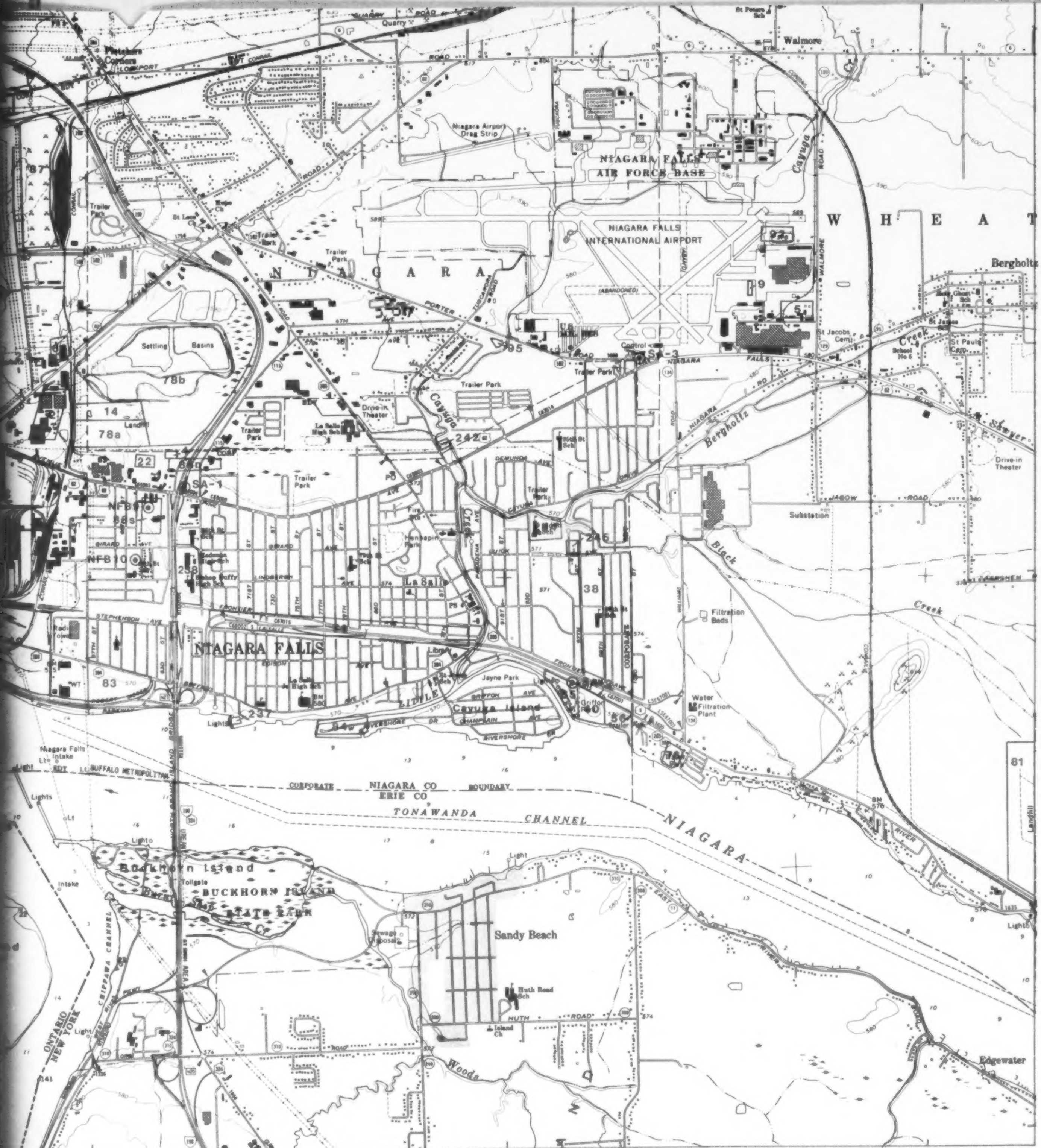

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WASTE-DISPOSAL SITES WITHIN 3 MILES

VER IN ERIE AND NIAGARA COUNTIES, NEW YORK